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# ZOOTAXA

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## New species of black flies (Diptera: Simuliidae) from Nepal

HIROYUKI TAKAOKA<sup>1,2</sup> & SUCHITRA SHRESTHA<sup>3</sup>

<sup>1</sup>*Institute of Biological Sciences, Faculty of Science, University of Malaya, Kuala Lumpur, 50603 Malaysia*

<sup>2</sup>*Department of Infectious Disease Control, Faculty of Medicine, Oita University, Yufu City, Oita, 879-5593 Japan.*

*E-mail: [takaoka@med.oita-u.ac.jp](mailto:takaoka@med.oita-u.ac.jp)*

<sup>3</sup>*P.O. Box 6304, Kathmandu, Nepal. E-mail: [suchitras2003@gmail.com](mailto:suchitras2003@gmail.com)*



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## Abstract

Ten new species of black flies are described based on larval, pupal and reared adult specimens collected at various localities in Nepal. All new species are assigned to the genus *Simulium* Latreille and further classified into five subgenera: one (*S. suchitrae* **sp. nov.**) in *Asiosimulium* Takaoka & Choochote, one (*S. jomsomense* **sp. nov.**) in *Eusimulium* Roubaud, three (*S. baglungense* **sp. nov.**, *S. butwalense* **sp. nov.**, *S. nuwakotense* **sp. nov.**) in *Gomphostilbia* Enderlein, two (*S. lekhaniense* **sp. nov.**, *S. letense* **sp. nov.**) in *Nevermannia* Enderlein, and three (*S. titarense* **sp. nov.**, *S. tamorense* **sp. nov.**, *S. tulshii* **sp. nov.**) in *Simulium* Latreille s. str. Among these, the first two new species also represent new records from Nepal of two subgenera, *Asiosimulium* and *Eusimulium*, respectively, both of which occur very rarely in the Oriental Region. The previous record from Nepal of *S. (G.) gombakense* Takaoka & Davies is corrected to that of *S. (G.) sachini* Takaoka & Henry, recently described from India. The male and mature larva of *S. (G.) sachini* are also described for the first time. The taxonomic affinities with related known species, if any, are noted for each new species. The keys to all 32 Nepalese species of black flies are provided.

**Key words:** *Simulium*, new species, description

## Introduction

The fauna of black flies (Diptera: Simuliidae) in Nepal has been relatively poorly studied. So far recorded from Nepal are 22 named and 3 unnamed species, all of which are assigned to the genus *Simulium* Latreille, and further classified into four subgenera: *Gomphostilbia* Enderlein (seven spp.), *Montisimulium* Rubtsov (two spp.), *Nevermannia* Enderlein (four spp.), and *Simulium* s. str. (12 spp.) (Adler & Crosskey 2010; Lewis 1964; Maskey 1985, 1989, 1998; Shrestha & Takaoka 2009).

In 2009 and 2010, one of us (S.S.) collected pupae and larvae of black flies in mid-western Nepal (e.g., Mustang, Beni, Baglung, Tansen and Butwal) and eastern Nepal (e.g., Taplejung and Ilam). Pupae were individually reared in plastic tubes for a few days until adults emerged. Emerged adults were each preserved in 80% ethanol, together with their associated pupal exuviae and cocoons, and examined under binocular and compound microscopes for species identification.

In this paper, ten new species are described and illustrated, and the previous record from Nepal of *S. (G.) gombakense* Takaoka & Davies (Shrestha & Takaoka 2009) is corrected to that of *S. (G.) sachini* Takaoka & Henry, recently described from India (Takaoka *et al.* 2010). The male and mature larva of *S. (G.) sachini* are also described for the first time.

In an appendix, all 32 species (22 known plus 10 new) of black flies recorded from Nepal are listed, and identification keys are provided, where possible, for females, males, pupae and mature larvae.

The procedures to treat specimens for observation and the methods of descriptions and illustrations of morphological features follow those of Takaoka (2003). The terms for morphological features and the definitions of subgenera of the genus *Simulium* used here follow those of Takaoka (2003) except the definitions of the subgenera *Asiosimulium* and *Eusimulium* which follow those of Takaoka & Choochote (2005a) and Adler *et al.* (2004), respectively. All type specimens are deposited at the Department of Infectious Disease Control, Faculty of Medicine, Oita University, Oita, Japan.

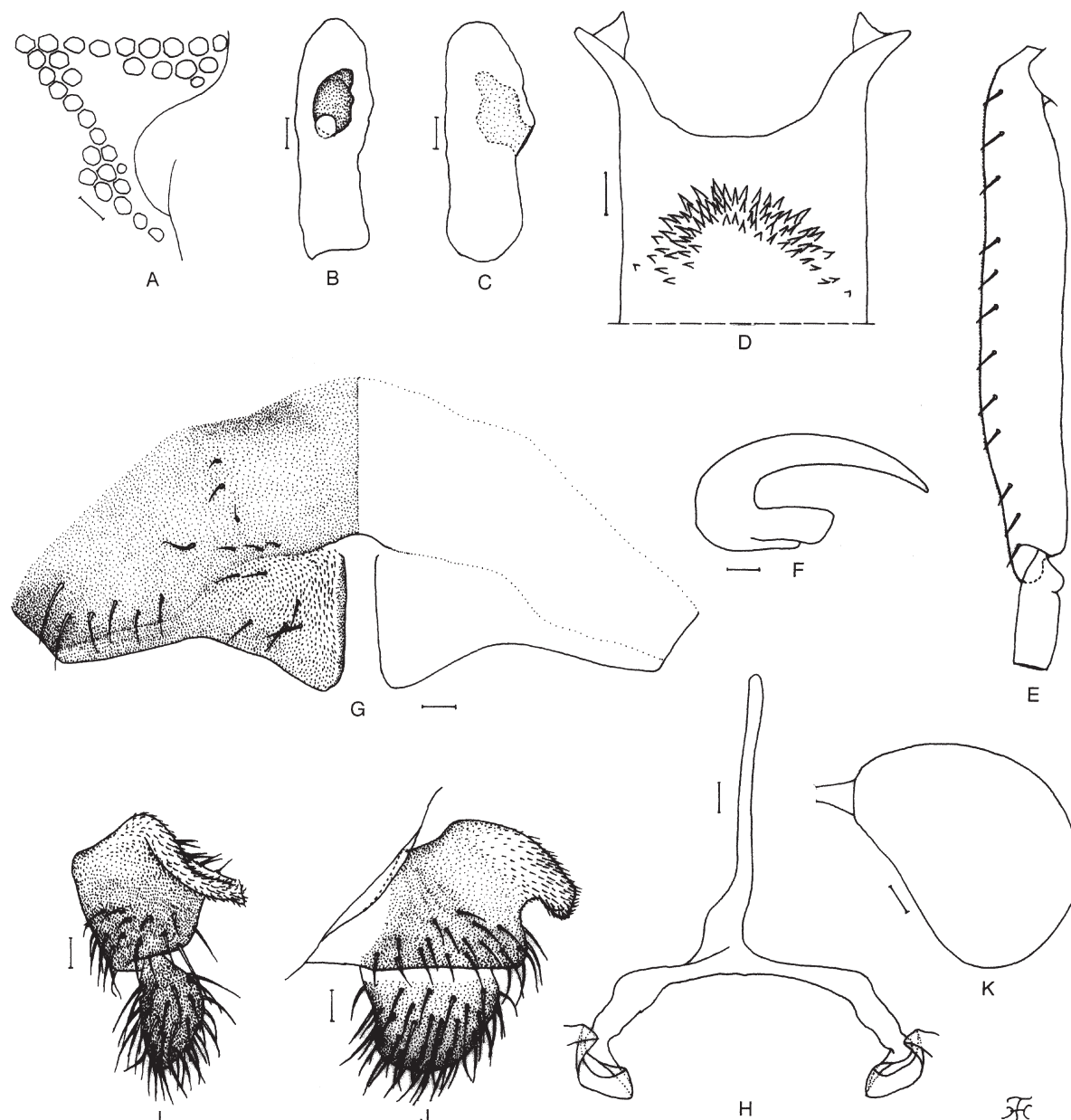
## Accounts for new species of black flies from Nepal

### (I) Subgenus *Asiosimulium* Takaoka & Choochote

#### *Simulium (Asiosimulium) suchitrae* Takaoka sp. nov.

**Description. Female.** Body length 2.3 mm. **Head.** Slightly narrower than thorax. Frons brownish-black, thinly whitish-gray pruinose and slightly shiny at certain angle of light, moderately covered with yellow hairs (except median longitudinal portion narrowly bare, and narrow area between antennal sockets bare) interspersed with several dark longer and stouter hairs along each lateral margin; median suture on lower portion absent; frontal ratio 1.56:1.00:1.97. Frons-head ratio 1.00:4.23. Fronto-ocular area (Fig. 1A) well developed, triangular, directed laterally and somewhat upward. Clypeus brownish-black, thinly whitish-gray pruinose and slightly shiny at certain angle of light, moderately covered with yellow hairs (except narrow portions near upper and lower margins bare) intermixed with dark longer and stouter hairs. Labrum 0.91 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, light to medium brown, except scape, pedicel, and anterior surface of 1st to 3rd flagellomeres dull yellow. Maxillary palp consisting of 5 segments, medium brown except 3rd segment blackish-brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.86:1.48; 3rd segment (Fig. 1B,C) not enlarged; sensory vesicle (Fig. 1B,C) roughly ellipsoidal, 0.30 times as long as 3rd segment, with large opening apically. Lacinia with 9 or 10 inner and 11 outer teeth. Mandible with 25 inner and 14 outer teeth. Cibarium (Fig. 1D) moderately concave posterodorsally and with 69 spinous processes elaborately arranged in narrow space between inner and outer walls, somewhat apart from posterodorsal margin; these processes arising from inner wall. **Thorax.** Scutum brownish-black, slightly to moderately shiny at certain angle of light, thinly gray pruinose on prescutellar area and densely covered with yellowish-white short hairs mixed with dark brown short hairs on anterior surface, and interspersed with several dark brown upright long hairs on prescutellar area. Scutellum medium brown, with many dark upright long hairs as well as yellowish-white short hairs. Postnotum dark brown, slightly shiny at certain angle of light, bare. Pleural membrane bare. Katepisternum longer than deep, brownish-black, shiny in light and bare. **Legs.** Entirely medium brown to brownish-black except some parts of all trochanters and extreme base of mid and hind tibiae dark yellow to light brown. Fore basitarsus moderately dilated, 6.91 times as long as its greatest width, and with moderate dorsal hair crest. Hind basitarsus (Fig. 1E) nearly parallel-sided though somewhat tapered near both ends, 6.69 times as long as its greatest width, 0.73 and 0.64 times as wide as greatest widths of tibia and femur, respectively; calcipala developed, short, 0.63 times as long as its width at base, and 0.50 times as wide as greatest width of basitarsus; pedisulcus developed. All claws (Fig. 1F) with large basal tooth 0.44 times as long as claw. **Wing.** Length 2.5 mm. Costa with 2 parallel rows of dark short spines as well as dark hairs. Subcosta with dark hairs except near apex bare. Hair tuft on stem vein dark. Basal portion of radius fully haired.  $R_1$  with dark spinules and hairs.  $R_2$  with dark hairs only. Basal cell and basal median cell absent. **Abdomen.** Basal scale dark brown, with fringe of yellowish-white long hairs. Dorsal and lateral surfaces of abdomen brownish-black to black, moderately covered with dark short hairs mixed with yellowish-white short hairs on tergite 2 and on each lateral surface of segments 2–4; tergites 2 and 6–8 shiny, although tergites 3–5 somewhat shiny at certain angle of light; ventral surface of abdomen brownish-black to black; segment 7 with large sternal plate medially. **Genitalia.** Sternite 8 (Fig. 1G) wide,

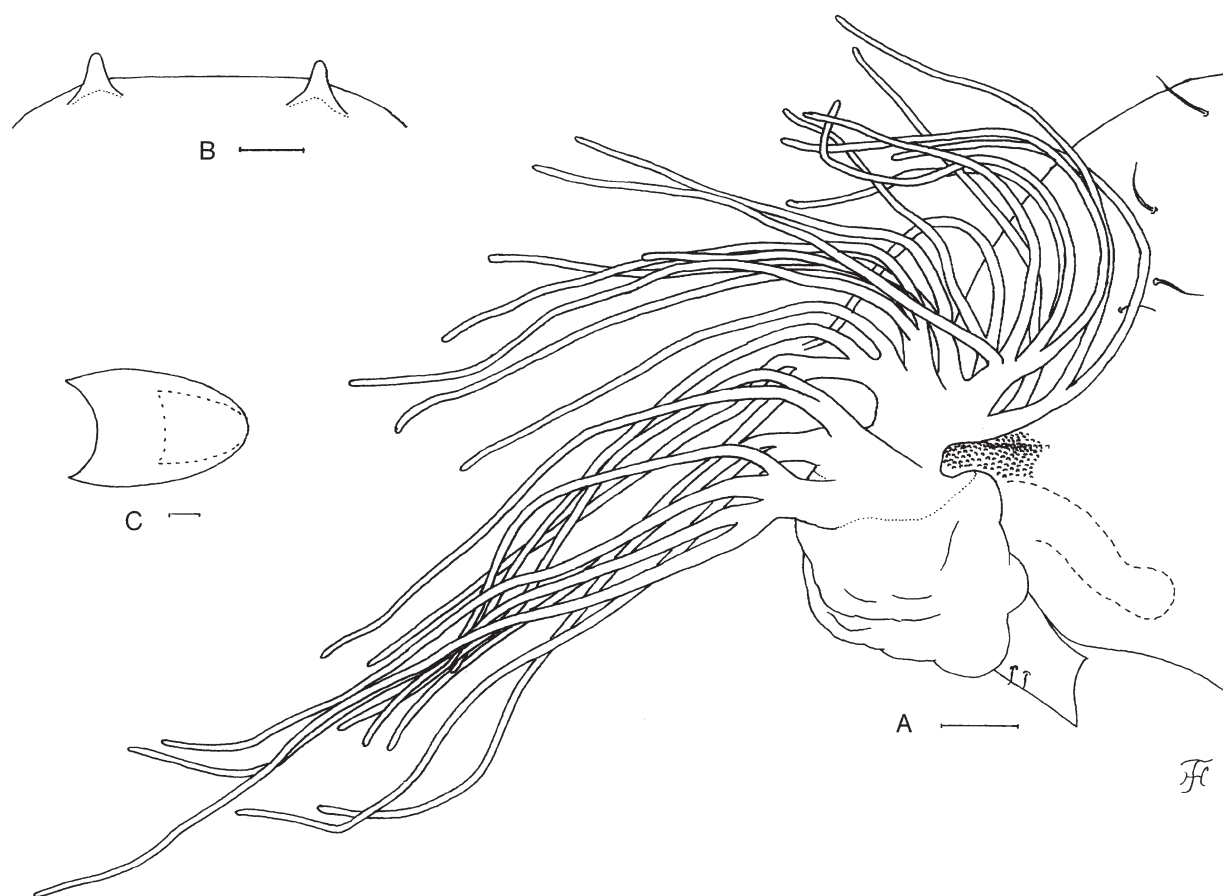
bare medially but furnished with 13 or 14 short to medium-long hairs on each side. Ovipositor valve (Fig. 1G) nearly triangular, thin, membranous except inner margin narrowly sclerotized, densely covered with microsetae interspersed with 6 or 7 short hairs; inner margins nearly straight, moderately separated from each other. Genital fork (Fig. 1H) inverted-Y-shaped, with well sclerotized, basally widened stem; each arm of moderate width, thin except basal and subapical portions well sclerotized, and coiled near apex. Paraproct in ventral view (Fig. 1I) subquadrate, with distinct process produced ventrally along anteromedial margin, with 7 or 8 spinous colorless sensilla on anteromedial surface; paraproct in lateral view (Fig. 1J) much wider than long, with 20 short to medium-long hairs on lateral and ventral surfaces. Cercus in ventral view (Fig. 1I) 0.8 times as long as paraproct, with numerous short and medium-long hairs; cercus in lateral view (Fig. 1J) rounded posteriorly, 0.71 times as long as its width at base. Spermatheca (Fig. 1K) pear-like, strongly sclerotized except duct unsclerotized, without distinct reticulate surface pattern; internal setae not discernible; accessory ducts subequal in diameter to each other and slightly larger than main duct.



**FIGURE 1.** Female of *Simulium* (*Asiosimulium*) *suchitrae* **sp. nov.** A, fronto-ocular area (right side; front view); B & C, 3rd segment of maxillary palp with sensory vesicle (right side; B, front view; C, lateral view); D, cibarium with many pointed processes elaborately arranged near posterodorsal margin (posterior view); E, basitarsus and 2nd tarsomere of hind leg (left side; outer view); F, claw with large basal tooth (lateral view); G, 8th sternite and ovipositor valves (ventral view); H, genital fork (ventral view); I & J, paraproct and cercus (right side; I, ventral view; J, lateral view); K, spermatheca (lateral view). Scale bars. 0.05 mm for E; 0.02 mm for A–D & G–K; 0.01 mm for F.

**Male.** Unknown.

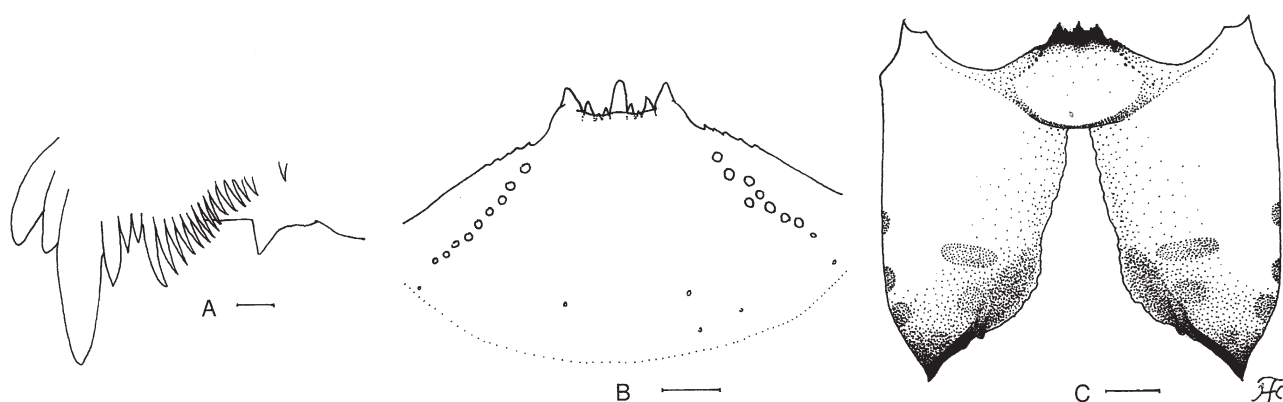
**Pupa.** Body length 3.5 mm. **Head.** Integument dark yellow, without tubercle; face with 1 simple medium-long trichome on each side, and frons with 1 (left side) or 2 (right side) simple medium-long trichomes on each side; antennal sheath without any projection and tubercle. **Thorax.** Integument dark yellow, bare except dorsal surface of posterior 1/2 sparsely or moderately covered with tubercles, and small area at base of gill densely covered with tubercles (Fig. 2A); thorax on each side with 9 simple trichomes (2 mediodorsally, 2 anterolaterally, 2 mediolaterally and 3 ventrolaterally), all medium-long except 1 of 2 anterolateral trichomes and all 3 ventrolateral trichomes short. Gill (Fig. 2A) of arborescent type, composed of 28 short slender thread-like filaments arranged from dorsal to ventral as  $\{[(2+2)+(2+1+1)+2+2]+[4+(1+1+2)]\}+(2+2)+(2+2)$  on left side, and  $\{[2+2+2+2+(2+2)]+[4+(1+1+2)]\}+(2+2)+(2+2)$  on right side; all filaments light to medium brown, variable in length ranging from 0.5 mm (1 filament of dorsal group) to 1.2 mm (1 filament of ventral group), with annular furrows (no distinct ridges) and densely covered with minute tubercles; gill with enlarged transparent bulbous organ basally. **Abdomen.** Dorsally, all segments nearly transparent except segment 9 yellowish; segment 1 smooth (without tubercle), with 1 short slender seta on each side; segment 2 with 1 short slender seta, 5 very short spinous setae and 1 very short minute seta on each side; segments 3 and 4 each with 4 stout hooks and 1 very short spinous or minute seta on each side; segments 5–9 each with comb-like groups of minute spines though very sparsely on segment 5 and without spine-combs on each side; segment 9 with pair of small cone-shaped terminal hooks (Fig. 2B). Laterally, segments 2–4 each with 3 very short spinous setae on each side; segment 9 with 2 grapnel-shaped hooklets on each side. Ventrally, all segments nearly transparent except segment 9 yellowish; segments 5–7 each with pair of simple stout hooks on each side; segments 4–8 each with comb-like groups of minute spines and on each side. **Cocoon** (Fig. 2C). Wall-pocket shaped, tightly woven, with anterodorsal margin thickly woven, and slightly extended ventrolaterally; individual threads invisible; 3.0 mm long by 2.0 mm wide.



**FIGURE 2.** Pupa of *Simulium* (*Asiosimulium*) *suchitrae* sp. nov. A, anterior part of thorax showing tubercles only near base of gill, 4 simple trichomes and gill with large transparent organ at its base and numerous filaments (left side; outer view); B, terminal hooks (end view); C, cocoon (dorsal view). Scale bars. 0.5 mm for C; 0.1 mm for A; 0.02 mm for B.



**Mature larva.** Body length 6.1 mm. Body grayish. Cephalic apotome whitish-yellow on anterior 2/5 or little more, dark yellow to light brown on posterior 3/5 or little less, and dark brown along posterior margin; head spots distinct, dark brown except anterior spot of posterolateral spots on each side indistinct; posterior spot of posterolateral spots on each side merged in dark brown background and posterior spot of mediolongitudinal spots connected posteriorly to dark brown area along posterior margin. Lateral surface of head capsule yellow except area above and posterior to eye-spot region light to medium brown, with distinct dark brown spots, i.e., 2 large spots and 1 small spot in front of posterior margin and 3 isolated small spots below eye-spot region. Ventral surface of head capsule yellow except central portion and posterior portion along posterior margin widely light to medium brown, with distinct dark brown elongate and round spots on each side of postgenal cleft though round spots appear to be merged into medium brown background. Cervical sclerites composed of 2 dark brown small elliptical pieces, not fused to occiput, widely separated medially from each other. Antenna consisting of 3 segments and apical sensillum, subequal to or little longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00:1.36:0.69. Labral fan with 30 main rays. Mandible (Fig. 3A) with mandibular serration consisting of 1 large tooth (1 small tooth probably lost on left side) (either 1 or 2 teeth apparently lost on right side); large tooth at right angle to mandible on apical side; comb-teeth composed of 3 teeth decreasing in size from 1st to 3rd; supernumerary serrations absent. Hypostoma (Fig. 3B) with 9 apical teeth in row; median and corner teeth well developed; lateral serration weakly developed anteriorly; 9 hypostomal bristles per side, lying slightly divergent posteriorly from lateral margin. Postgenal cleft (Fig. 3C) deep, reaching posterior margin of hypostoma. Thoracic and abdominal cuticle bare except both sides of anal sclerite moderately covered with simple colorless setae. Rectal scales not discernible. Rectal organ compound, each of 3 lobes with 13–17 finger-like secondary lobules. Anal sclerite X-shaped, with anterior arms 0.94 times as long as posterior ones; anterior arms broadened, and space between arms widely sclerotized basally; 8 sensilla just posterior to basal juncture area; accessory sclerite absent. Last abdominal segment somewhat expanded ventrally forming ventral bulge, visible as very small ventral papilla when viewed from side. Posterior circlet with 90 rows of up to 16 hooklets per row.



**FIGURE 3.** Mature larva of *Simulium (Asiosimulium) suchitrae* sp. nov. A, apical portion of mandible; B, hypostoma; C, head capsule showing long postgenal cleft (ventral view); Scale bars. 0.1 mm for C; 0.04 mm for B; 0.01 mm for A.

**Type specimens.** Holotype female (with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from a pupa collected from a small stream slowly flowing on rocks (water temperature 15°C, shaded, altitude 1,826 m, 28°57'61.5" N, 83°51'02.0" E) near Titar, Mustang, Nepal, 23.IX.2009. Paratype: 1 mature larva, same data as those of holotype.

**Biological notes.** The pupa and larva of this new species were collected with larvae of *S. (Montisimulium) dattai* Takaoka & Somboon.

**Etymology.** The specific name *suchitrae* is in honor of Miss Suchitra Shrestha, junior author, who collected this new species, together with many other new species in her recent field surveys in Nepal.

**Remarks.** This new species is assigned to the subgenus *Simulium (Asiosimulium)* defined by Takaoka & Choochote (2005a) in that it has a combination of the following characteristics: numerous spinous processes on the cibarium (Fig. 1D), hairs on the basal portion of the radial vein, and a large basal tooth of the claw (Fig.

1F) in the female, gill filaments of arborescent type (Fig. 2A), dorsal surface of abdominal segments 5–9 without spine-combs, ventral surface of abdominal segments 5–7 each with pair of simple hooks on each side and lateral surface of abdominal segment 9 with grapnel-shaped hooklets in the pupa, and deep postgenal cleft (Fig. 3C) in the larva.

This is the third species of the subgenus *Simulium* (*Asiosimulium*) and represents a new record of this subgenus from Nepal. This subgenus was so far represented by only two species, i.e., *S. (A.) oblongum* Takaoka & Choochote and *S. (A.) wanchaii* Takaoka & Choochote, both of which were described from Thailand (Takaoka & Choochote 2005a, 2006).

The female of *S. (A.) suchitrae* **sp. nov.** is distinguished from those of the two known species by the genital fork without any projection (Fig. 1H), the short cercus (much shorter than its basal width) (Fig. 1I,J) and a pear-like spermatheca (Fig. 1K). The pupa of this new species is distinguished from that of *S. (A.) oblongum* by the frons lacking any tubercle. The pupa as well as the male and larva of *S. (A.) wanchaii* is not known.

The pupa of this new species is most distinctive in having a large transparent bulbous organ at the base of the gill (Fig. 2A), which occurs very rarely in the Oriental species of black flies. Until now, only two species of the *multistriatum* species-group of the subgenus *Simulium* (*Simulium*), i.e., *S. (S.) rotifilis* Chen & Zhang from China (Chen & Zhang 1998) and *S. (S.) bullatum* Takaoka & Choochote from Thailand (Takaoka & Choochote 2005b), have been reported to bear such a large bulbous organ.

## (II) Subgenus *Eusimulium* Roubaud

### *Simulium* (*Eusimulium*) *jomsomense* Takaoka & Shrestha **sp. nov.**

**Description. Female.** Body length 3.2 mm. **Head.** Slightly narrower than width of thorax. Frons brownish-black, thinly whitish-gray pruinose, not shiny, densely covered with yellow recumbent short hairs interspersed with several dark brown hairs along each lateral margin; frontal ratio 1.66:1.00:2.15. Frons-head ratio 1.00:4.50. Fronto-ocular area (Fig. 4A) directed laterally and upward, deep, pointed apically. Clypeus brownish-black, thinly whitish-gray pruinose, not shiny, densely covered with yellow short to long hairs. Labrum 0.58 times as long as clypeus. Antenna composed of scape, pedicel, and 9 flagellomeres, medium to dark brown except scape and pedicel yellow. Maxillary palp composed of 5 segments, light to medium brown except segments 1 and 2 ochreous, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.79:2.23; sensory vesicle (Fig. 4B) greatly enlarged, ellipsoidal, 0.50–0.55 times as long as 3rd segment, and with medium-sized opening medially. Maxillary lacinia with 8–10 inner and 16 outer teeth. Mandible with 18 (left side) or 22 (right side) inner teeth and lacking outer teeth. Cibarium smooth. **Thorax.** Scutum brownish-black except anterolateral calli dark brown, thinly gray pruinose and shiny on shoulders, lateral surface along lateral margins and on prescutellar area when illuminated at certain angle of light, densely covered with whitish-yellow to yellow recumbent short hairs. Scutellum brownish-black, covered with whitish-yellow short and long hairs. Postnotum brownish-black, gray pruinose, and with submedian patch of whitish-yellow short hairs on each side. Pleural membrane bare. Katepisternum dark brown, longer than deep, shiny when illuminated at certain angle of light, and bare. **Legs.** Foreleg: coxa and trochanter whitish-yellow; femur whitish-yellow except apical cap medium brown (though yellow on basal 1/2 of outer surface and dark yellow on rest of outer surface from middle to basal edge of apical cap); tibia yellowish-white except base light brown and apical cap medium brown; tarsus dark brown; basitarsus somewhat dilated, 6.58 times as long as its greatest width. Midleg: coxa dark brown; trochanter whitish-yellow; femur whitish-yellow to yellow except apical tip dark brown (though somewhat darker on small portion of posterior surface anterior to apical cap); tibia whitish-yellow except apical cap dark brown; tarsus dark brown except little less than basal 1/2 light to medium brown. Hind leg: coxa medium brown; trochanter dark yellow; femur yellow except apical cap dark brown (though light brown on small portion of posterior and outer surface anterior to apical cap); tibia yellow on basal 2/3, light brown on basal 1/2 of rest and dark brown on apical cap; basitarsus yellow to dark yellow except base light brown and apical 1/5 or little more dark brown; rest of tarsus medium to dark brown except basal 1/2 of 2nd tarsomere whitish-yellow; basitarsus (Fig. 4C) slender, nearly parallel-sided on basal 1/2, then slightly narrowed toward apex, 5.78 times as long as wide, and 0.78 and 0.64 times as wide as tibia and femur, respectively; calcipala (Fig. 4C) well developed, 0.69 times as long as basal width, and 0.43 times as



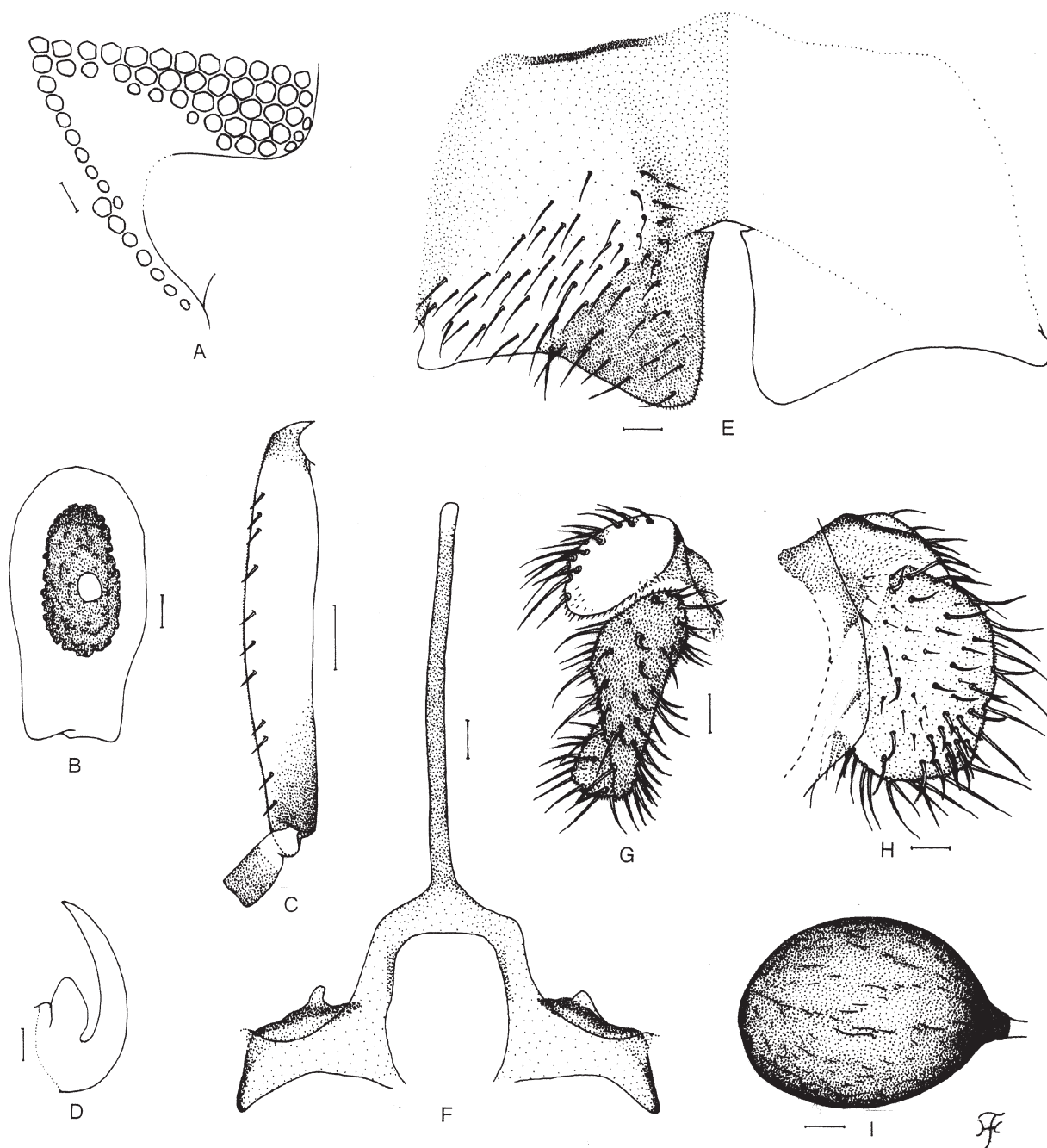
wide as greatest width of basitarsus; pedisulcus (Fig. 4C) moderately developed. Claw (Fig. 4D) with large basal tooth 0.48 times as long as claw. **Wing.** Length 2.8 mm. Costa with dark brown spinules and light brown hairs except basal portion with patch of yellow hairs. Subcosta with light brown hairs except near apex bare. Hair tuft on stem vein yellow. Basal portion of radial vein fully haired.  $R_1$  with dark brown spinules and light brown hairs.  $R_2$  with light brown hairs only. Basal cell and basal median cell absent. **Abdomen.** Basal scale medium brown, with fringe of yellow long hairs; dorsal surface of abdominal segments medium to dark brown except tergal plate of segment 2 ochreous; all segments moderately to densely covered with whitish-yellow short hairs, interspersed with dark brown short to medium-long hairs dorsally and dorsolaterally on few posterior segments; tergites 8 and 9 slightly shiny when illuminated at certain angle of light; segment 7 with large sternal plate medially. **Genitalia.** Sternite 8 (Fig. 4E) weakly to moderately sclerotized except anterior margin well sclerotized (except medial portion), bare medially, and with 37–42 short to long hairs on each side. Ovipositor valves (Fig. 4E) roughly triangular, rounded medioposteriorly, thin, membranous, densely covered with microsetae interspersed with 15 or 16 short to medium-long hairs; inner margin very weakly sclerotized and narrowly darkened only along basal 1/2. Genital fork (Fig. 4F) of usual inverted-Y-form, stem slender and well sclerotized; arms of moderate width, with wide apical plate strongly folded anteriorly, bearing small slightly sclerotized projection on anterior margin. Paraproct in ventral view (Fig. 4G) short, with anterior surface strongly sclerotized and with almost transparent flat anteroventral surface, of which antero-medial margin rimmed with 14 or 15 medium-long hairs; paraproct in lateral view (Fig. 4H) slightly produced ventrally beyond ventral margin of cercus, covered with microsetae interspersed with 3 or 4 short hairs on lateral surface. Cercus in ventral view (Fig. 4G) much longer than paraproct, and strongly curved inward; cercus in lateral view (Fig. 4H) subquadrate, 0.75 times as long as its basal width, and with numerous fine and stout short to medium-long hairs. Spermatheca (Fig. 4I) ovoid, well sclerotized, with nipple-like well sclerotized extension at base of duct, with many fissures on surface; internal setae absent; both accessory ducts subequal in diameter to each other, and also to main duct.

**Male.** Body length 3.3 mm. **Head.** Somewhat wider than thorax. Upper eye consisting of 18 vertical columns and 20 horizontal rows of large facets. Face brownish-black, gray pruinose. Clypeus brownish-black, gray pruinose, moderately covered with yellow long hairs. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown except scape, pedicel, and extreme base of 1st flagellomere yellow; 1st flagellomere somewhat elongate, 1.80 times as long as 2nd one. Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.95:2.22; sensory vesicle (Fig. 5A) medium-sized, globular or ellipsoidal, 0.29 times as long as 3rd segment, with very small opening. **Thorax.** Scutum black, thinly gray pruinose and shiny on shoulders, along lateral margins and on prescutellar area when illuminated at certain angle of light, densely covered with yellow short recumbent hairs interspersed with yellow long upright hairs on prescutellar area. Scutellum dark brown to brownish-black, with yellow short and long hairs. Postnotum brownish-black, bare. Pleural membrane and katepisternum as in female. **Legs.** Foreleg: coxa yellow; trochanter light to medium brown; femur medium brown except apical cap dark brown; tibia light to dark brown except median large portion on outer surface yellowish-white; tarsus dark brown; basitarsus slightly dilated, 8.32 times as long as its greatest width. Midleg: coxa dark brown; trochanter light to medium brown; femur light brown except apical cap dark brown; tibia yellow on basal 1/2 (though base somewhat dark), light to dark brown on apical 1/2 (gradually darkened toward apex) (border of light and dark areas not well defined); tarsus medium to dark brown. Hind leg: coxa dark brown; trochanter medium brown; femur medium brown except apical cap dark brown; tibia yellow on basal 1/3 or little more (though extreme base medium brown) and medium to dark brown on rest; tarsus medium brown except little less than basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 5B) enlarged, spindle-shaped, 4.76 times as long as its greatest width, and 0.80 and 0.83 times as wide as greatest width of hind tibia and femur, respectively; calcipala (Fig. 5B) well developed, short, 0.75 times as long as its basal width, and 0.29 times as wide as greatest width of basitarsus; pedisulcus (Fig. 5B) well developed. **Wing.** As in female except length 2.5 mm and subcosta with 1–3 hairs. **Abdomen.** Basal scale dark brown, with fringe of yellow long hairs. Dorsal surface of abdominal segments medium brown to brownish-black, moderately covered with yellow short to long hairs interspersed with light to medium brown short hairs on few posterior segments; segments 2 and 5–8 each with pair of shiny whitish-gray pruinose dorsolateral or lateral spots when illuminated at certain angle of light. **Genitalia.** Coxite in ventral view (Fig. 5C) large, rectangular (though tapered near posterior end), 1.46 times as long as greatest width, and moderately covered with distinct hairs on posterior 2/5 of ventral

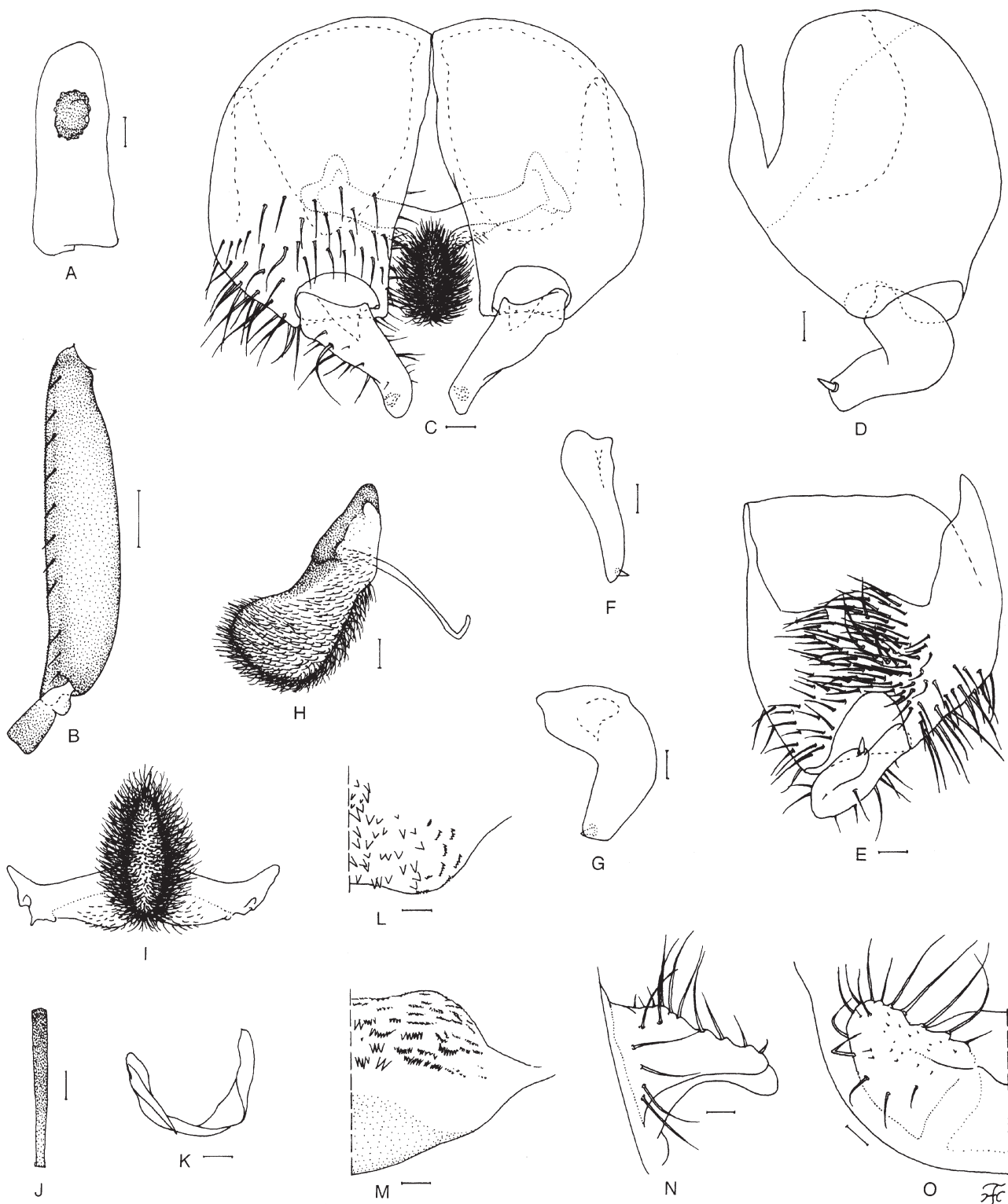
surface; coxite in lateral view (Fig. 5D) large and rounded; coxite in dorsal view (Fig. 5E) densely covered with distinct hairs medially. Style in ventral view (Fig. 5C) and in medial view (Fig. 5F) short, 0.54 times as long as coxite, tapered toward apex, with single spine subapically, and covered with several short to long distinct hairs mainly on ventrolateral surface; style in lateral view (Fig. 5D) and in posterolateral view (Fig. 5G) falcate, markedly curved dorsally in middle, with apex truncated. Ventral plate in ventral view (Fig. 5C) roughly Y-shaped, with hairy narrow median keel directed posteroventrally, and hairy wide membranous flanges extending along basal arms; basal arms well sclerotized, stout, widely diverged laterally, with dilated apex; ventral plate in lateral view (Fig. 5H) with wide hairy median keel with round apex; ventral plate in end view (Fig. 5I) roughly inverted T-shaped, with hairy narrow median keel and hairy membranous flanges extending laterally along posterior margin of basal arms. Median sclerite in lateral view (Fig. 5H) arising near anterior margin of ventral plate, markedly bent dorsally near apex; median sclerite in end view (Fig. 5J) well sclerotized, narrow, nearly parallel-sided, though slightly narrowed apically. Paramere in dorsal view (Fig. 5K) narrow, with 1 long hook directed posterolaterally. Aedeagal membrane (Fig. 5L,M) transparent, moderately covered with small stout cone-shaped spines as well as comb-like spines; dorsal plate in end view (Fig. 5M) weakly sclerotized, horizontally spindle-shaped. Abdominal segment 10 without distinct hairs on each side. Cercus (Fig. 5N,O) well developed, moderately produced posteriorly, with 12 or 13 medium-long to long distinct hairs.

**Pupa.** Body length (excluding gill filaments) about 3.5 mm. **Head.** Integument yellowish-brown, moderately covered with round tubercles; antennal sheath almost bare; frons with 2 simple or bifid very long trichomes (1 with coiled apex, 1 with uncoiled apex) (Fig. 6A) on each side; face with 1 very long simple or bifid trichome with coiled or uncoiled apex (Fig. 6B) on each side. **Thorax.** Integument yellowish-brown, moderately (more sparsely on some parts on dorsal surface than on frons) covered with round tubercles, and with 3 very long simple trichomes with coiled apices (Fig. 6C) mediodorsally, 2 simple trichomes (1 very long with coiled apex, 1 long with uncoiled apex) (Fig. 6D) anterolaterally, 1 long simple or bifid trichome with uncoiled apex (Fig. 6E) mediolaterally, and 3 simple trichomes (1 long with coiled or uncoiled apex, 1 long with uncoiled apex, 1 short with uncoiled apex) (Fig. 6F) ventrolaterally, on each side. Gill (Fig. 6G,H) with 4 slender thread-like filaments, longer than pupal body, arranged vertically in dorsal and ventral pairs arising from very short common basal stalk; common basal stalk with transparent portion ventrally; stalk of dorsal pair short, nearly as long as common basal stalk, 1.1–1.2 times as thick as interspiracular trunk; ventral pair almost sessile; 2 filaments of dorsal pair lying at vertical plane, subequal in length (5.1 mm including common basal stalk) to each other, 2 filaments of ventral pair lying at oblique plane, subequal in length to each other (4.1 mm including common basal stalk) (measurements based only on 2 intact filaments of male pupal exuviae since apices of all other filaments were cut off); relative thickness of 4 filaments from dorsal to ventral 1:00:1.00:0.88:0.88 in female pupal exuviae and 1.00:0.94:0.77:0.82 in male pupal exuviae; dorsalmost filament first directed upward and bent forward, diverging basally from lowermost filament at angle of 90 degrees or little more when viewed laterally; all filaments yellowish-brown, gradually tapered toward apex, furnished with distinct annular ridges and furrows, and densely covered with minute tubercles on outer surface. **Abdomen.** Dorsally, segments 1 and 2 almost entirely weakly-sclerotized, light yellowish-brown except posterior 1/5 of segment 2 not pigmented, and densely or moderately covered with minute tubercles; segment 1 with 1 medium-long slender simple seta on each side; segment 2 with 1 short simple or bifid seta and 5 short spinous setae (1 of which is somewhat shorter than others) on each side; segments 3 and 4 weakly sclerotized and light brown on anterior 1/5 to 1/4, each with 4 dark stout hooks and 1 short spinous seta on each side; segment 5 slightly darkened along anterior margin, with 1 dark short spinous seta and without spine-combs and comb-like groups of minute spines on each side; segments 6–8 each with spine-combs and comb-like groups of minute spines lying transversely along anterior margin on each side, though distinct spines in spine-combs vary in number between sides and sexes, and among segments, i.e., 1 or 2 on segment 6, 2 or 3 on segment 7 and 2 or 5 on segment 8 in female pupal exuviae, 2 or 3 on segment 6, 6 or 8 on segment 7 and 6 or 7 on segment 8 in male pupal exuviae, and distinct spines also vary in shape from simple or bifid or trifid in male pupal exuviae (Fig. 6I); segment 9 weakly sclerotized, yellow, with comb-like groups of minute spines on each side and pair of cone-shaped terminal hooks (Fig. 6J), though those of male pupal exuviae appearing to be somewhat smaller than those of female pupal exuviae. Ventrally, segments 3–8 nearly transparent, segment 9 weakly sclerotized and yellowish-brown; segment 3 with 2 short slender simple setae on each side; segment 4 with 4 short dark simple spinous setae on each side; segment 5 with 2 dark bifid

hooks and few short simple spinous setae (dark in female pupal exuviae) on each side; segments 6 and 7 each with 1 dark bifid inner hook and 1 dark simple outer hook, and few short simple spinous setae (dark in female pupal exuviae) on each side; segments 4–8 each with comb-like groups of minute spines. Segment 9 without grapnel-shaped hooklets on each lateral side. **Cocoon** (Fig. 6K,L). Simple, wall-pocket-shaped, neatly (in female cocoon) or somewhat roughly (in male cocoon) woven, thin except anterior margin somewhat thickly woven in female cocoon, and not extending ventrolaterally; floor woven on posterior 2/5; individual threads usually visible; 3.5–4.5 mm long by 1.4 mm wide.

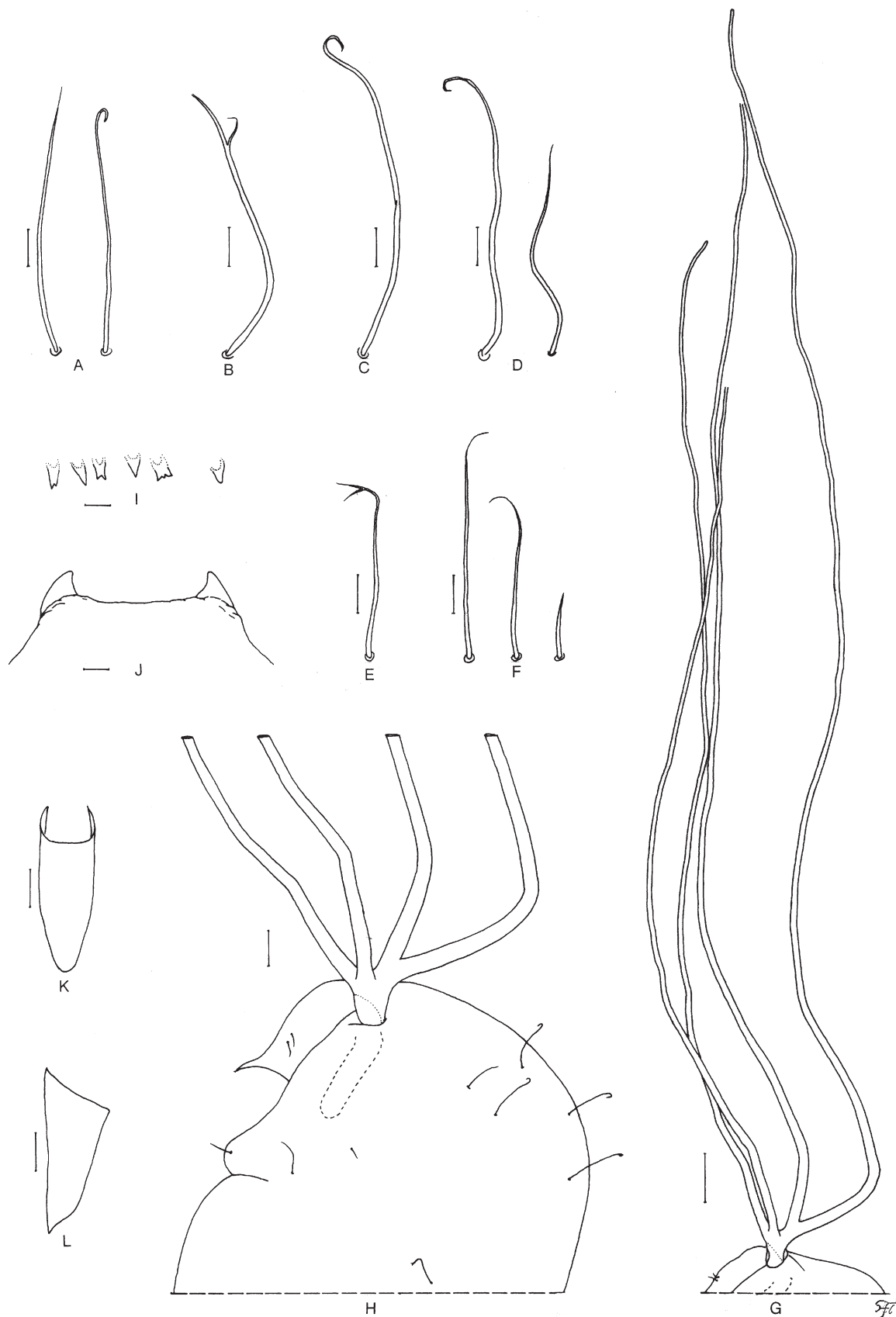


**FIGURE 4.** Female of *Simulium* (*Eusimulium*) *jomsomense* **sp. nov.** A, fronto-ocular area (right side; front view); B, 3rd segment of maxillary palp with sensory vesicle (left side; front view); C, basitarsus and 2nd tarsomere of hind leg (left side; outer view); D, claw with large basal tooth (lateral view); E, 8th sternite and ovipositor valves (ventral view); F, genital fork (ventral view); G & H, paraproct and cercus (G, left side and ventral view; H, right side and lateral view); I, spermatheca showing sclerotized neck (lateral view). Scale bars. 0.1 mm for C; 0.02 mm for A, B & E–I; 0.01 mm for D.



**FIGURE 5.** Male of *Simulium* (*Eusimulium*) *jomsomense* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (right side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D & E, coxite and style (right side; D, lateral view; E, dorsal view); F & G, style (right side; F, medial view; G, ventrolateral view); H, ventral plate and median sclerite (lateral view); I, ventral plate (end view); J, median sclerite (end view); K, paramere with 1 hook (right side; posterodorsal view); L, aedeagal membrane (ventral view); M, aedeagal membrane and dorsal plate (end view); N & O, 10th abdominal segment with cercus (right side; N, lateral view; O, end view). Scale bars. 0.1 mm for B; 0.02 mm for A & C–O.





**FIGURE 6.** Pupa of *Simulium* (*Eusimulium*) *jomsomense* **sp. nov.** A, frontal trichomes; B, facial trichome; C–F, thoracic trichomes (C, mediodorsal; D, anterolateral; E, mediolateral; F, ventrolateral); G, gill filaments (left side; outer view); H, anterior part of thorax showing trichomes and basal part of gill filaments (left side; outer view); I, spine-combs on dorsal surface of abdominal segment 8 (left half); J, terminal hooks (end view); K & L, cocoon (K, dorsal view; L, lateral view). Scale bars. 1.0 mm for K & L; 0.2 mm for G; 0.1 mm for H; 0.02 mm for A–F, I & J.



**Mature larva.** Unknown.

**Type specimens.** Holotype female (with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a moderately-flowing stream (water temperature 10.0°C, exposed to the sun, altitude 2,745 m, 28°78'67.3" N, 83°73'38.7" E), Jomsom, Mustang, Nepal, 23. IX. 2009. Paratype: 1 male (with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), same data as those of the holotype.

**Biological notes.** The pupae of this new species were collected from stalks of grasses trailing in water. No other species was collected.

**Etymology.** The species name *jomsomense* refers to the locality name, Jomsom, where this new species was collected.

**Remarks.** *Simulium* (*E.*) *jomsomense* **sp. nov.** is assigned to the subgenus *Simulium* (*Eusimulium*), redefined by Adler *et al.* (2004) by having the female postnotum bearing a patch of hairs on each side, the spermatheca typically with a sclerotized neck (Fig. 4I), the male ventral plate not lamellate, with a narrow body bearing a haired median keel and elongate stout arms (Fig. 5C), the style small, short and with an apical spine (Fig. 5C–G), the paramere with a single hook (Fig. 5K), the cercus enlarged (Fig. 5N,O), and the pupal gill with four slender filaments (Fig. 6G).

This new species is characterized by the combination of the following male characteristics: postnotum without a patch of hairs on each side, hind basitarsus somewhat enlarged and spindle-shaped (Fig. 5B), ventral plate with a large round median lobe directed ventrally (Fig. 5C) and hairy membranous flange along the posterior margin of each arm (Fig. 5I), and aedeagal membrane with relatively large spines as well as comb-like groups of minute spines (Fig. 5L,M).

The subgenus *Eusimulium* includes 36 named species which are very similar in adult females, males and pupae to one another. This subgenus is mainly distributed in the Holarctic Region though a few to several species are known in the Neotropical, Ethiopian and Oriental Regions (Adler & Crosskey 2010).

In the Oriental Region, four species of this subgenus are known (Adler & Crosskey 2010): *S. (E.) angustipes* Edwards, widely distributed from western Europe to Kazakhstan, Siberia and Hebei, China (Crosskey *et al.* 1989), *S. (E.) weiningense* Chen and Zhang from Guizhou, China (Chen & Zhang 1997), *S. (E.) taipei* (Shiraki) from Taiwan (Shiraki 1935), and *S. (E.) satsumense* Takaoka from the Nansei Islands, Japan (Takaoka 1976). The present new species is easily distinguished from *S. (E.) angustipes* by the enlarged, spindle-shaped male hind basitarsus (c.f., male hind basitarsus is narrow and parallel-sided in *S. (E.) angustipes* according to Davies (1966)), from *S. (E.) weiningense* by the female genital fork with a small projection directed anteriorly from each lateral plate, the darker male legs, and the pupal abdominal segment 5 without spine-combs on the dorsal surface, from *S. (E.) taipei* by the brownish-black female scutum (c.f., reddish brown in *S. (E.) taipei* according to the original description), and from *S. (E.) satsumense* by the female ovipositor valve with 15 or 16 short to medium-long hairs and the bicolored male legs (c.f., ovipositor valve is covered with a few long hairs and the male legs are almost entirely black in *S. (E.) satsumense*).

In Simla and its surrounding hills, northwestern India, one species was also recorded under the name of *S. (E.) aureum* Fries, a type species of this subgenus, originally described from western Europe (Puri 1933). This species appears to be very similar to the present new species in that the ventral plate has hairy membranous flanges along the basal arms and a large round median lobe directed ventrally, and the male hind basitarsus is enlarged. The present new species is barely distinguished from this Indian species by the yellow fore coxa and the hind tibia which is yellow on the basal 1/3 and medium to dark brown on the rest (c.f., the fore coxa is brownish-black and the hind tibia is yellow on the basal 1/2 and brownish-black on the rest according to the description by Puri (1933)). The identification of this Indian species is probably wrong, because *S. (E.) aureum* has a narrow, parallel-sided male hind basitarsus and a narrow body of the ventral plate when viewed laterally (Davies 1966). Datta (1985) recorded *S. (E.) aureum* from Kashmir, northwestern India, while noting that this might be a new species which might prove to be closer to *S. (E.) latizonum* Rubtsov or *S. (E.) rubzovianum* (Sherban), both of which were synonymized as *S. (E.) angustipes* and *S. (E.) velutinum* (Santos Abreu), respectively (Adler & Crosskey 2010). *Simulium* (*E.*) *velutinum*, a species described from Canary Islands and widespread in the circum-Mediterranean area differs from the present new species by lacking a dark sclerotized nipple-like extension from the spermatheca at the base of the spermathecal duct (Crosskey 1988).

It is noteworthy that *S. (E.) azorensis* Carlson from Azores Archipelago has the ventral plate with hairy membranous flanges as well as the enlarged male hind basitarsus (Crosskey 1986), suggesting a close similarity to the present new species. However, *S. (E.) azorensis* apparently differs by having the basal fringe of the male abdomen entirely black.

*Simulium (E.) nigrofusipes* Rubtsov from Tadzhikistan and Armenia (Rubtsov 1989) appears to be similar to this new species in having the enlarged, spindle-shaped male hind basitarsus, the female ovipositor valve furnished with numerous hairs, and the female genital fork with a small projection directed from each lateral plate. However, there are differences in the ventral plate between the two species: e.g., *S. (E.) nigrofusipes* lacks hairy membranous flanges extending along the basal arms.

### (III) Subgenus *Gomphostilbia* Enderlein

#### *Simulium (Gomphostilbia) baglungense* Takaoka & Shrestha sp. nov.

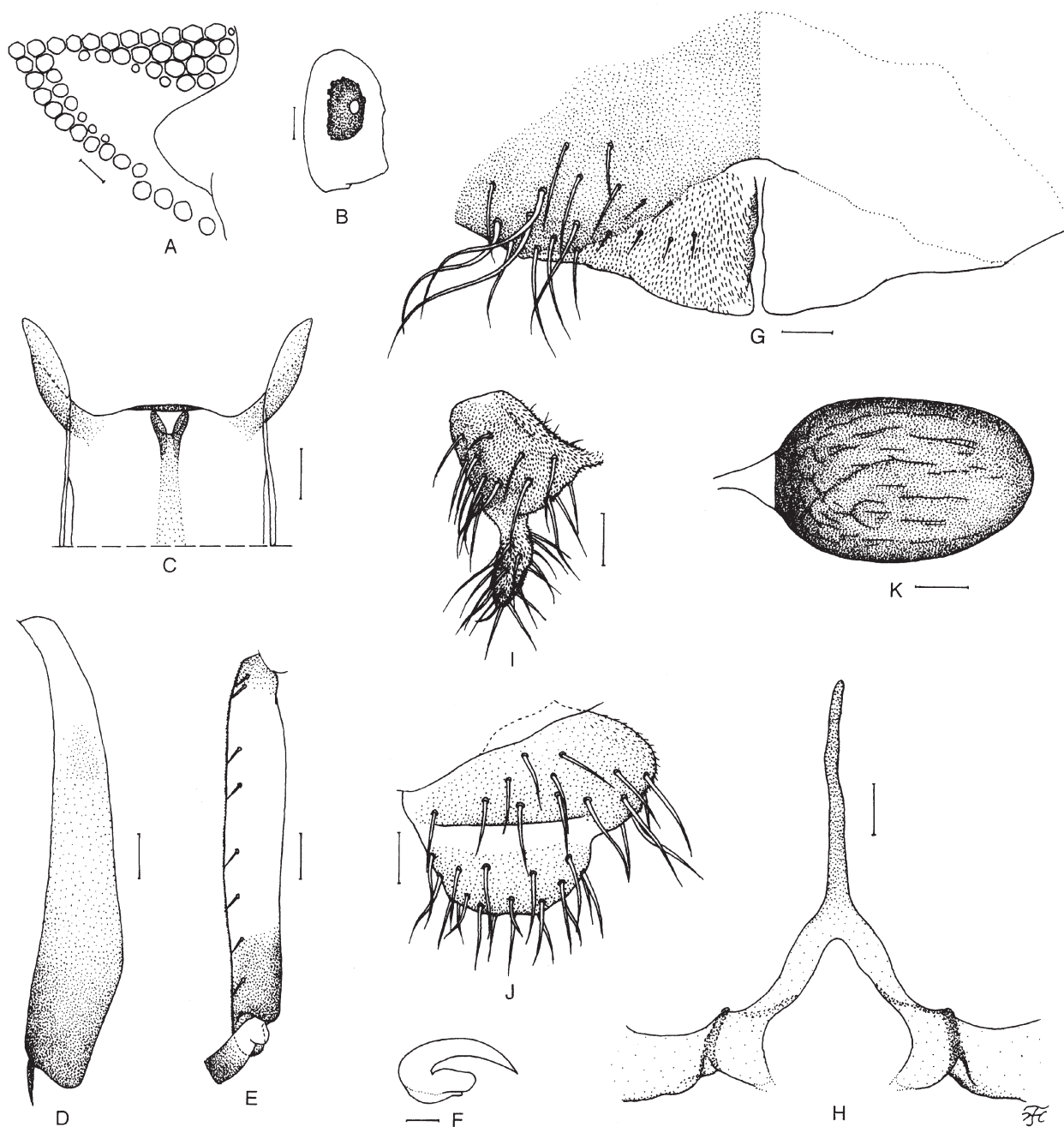
**Description. Female.** Body length 1.7 mm. **Head.** Nearly as wide as thorax. Frons brownish-black, dull, densely covered with yellowish-white scale-like recumbent hairs interspersed with few dark simple long hairs along each lateral margin; frontal ratio 1.46:1.00:1.46; frons-head ratio 1.00:3.85. Fronto-ocular area (Fig. 7A) well developed, deep, directed laterally and upward. Clypeus brownish-black, thinly white pruinose, shiny when illuminated at certain angle of light, densely covered with yellowish-white scale-like long hairs interspersed with several dark simple long hairs mainly along lateral margin on each side (except area along dorsal margin narrowly bare). Labrum 0.67 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown except scape, pedicel and base of 1st flagellomere yellow. Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th and 5th segments 1.00:1.03:2.21; 3rd segment (Fig. 7B) somewhat swollen; sensory vesicle (Fig. 7B) enlarged, ellipsoidal, 0.51 times as long as 3rd segment, with medium-sized opening medially. Maxillary lacinia with 11 or 13 inner and 16 or 17 outer teeth. Mandible with 25 inner and 8 outer teeth though short distance of outer margin from apex without teeth. Cibarium (Fig. 7C) with posterodorsal margin medially folded anteriorly forming short wide plate, and with darkened mediolongitudinal band bearing forked apex. **Thorax.** Scutum dark brown, shiny, densely covered with yellowish-white scale-like recumbent short hairs. Scutellum dark brown, covered with yellowish-white short hairs as well as dark brown upright long hairs. Postnotum dark brown, bare, slightly shiny and white pruinose when illuminated at certain angle of light. Pleural membrane bare. Katepisternum dark brown, longer than deep, moderately covered with yellowish fine hairs interspersed with dark brown hairs. **Legs.** Foreleg: coxa whitish-yellow; trochanter whitish-yellow except apical 1/2 dark yellow; femur light brown, with apical cap medium brown (though extreme tip light brown); tibia medium brown except base and median large portion on outer surface yellow to light brown; tarsus dark brown, with moderate dorsal hair crest; basitarsus somewhat dilated, 6.79 times as long as its greatest width. Midleg: coxa medium brown with posterior surface dark brown; trochanter whitish-yellow; femur light brown, with apical cap medium brown (though base much lighter and extreme apical tip light brown); tibia whitish-yellow at base, gradually darkened from light brown to medium brown; tarsus light to medium brown except basal 1/2 or little less of basitarsus dark yellow. Hind leg: coxa medium brown; trochanter whitish-yellow; femur light brown except base whitish-yellow and apical cap medium brown (though extreme tip light brown); tibia (Fig. 7D) light brown except base whitish-yellow and apical cap medium to dark brown (though subbasal area somewhat darkened appearing as subbasal band; tibia moderately covered with yellow fine hairs on outer and posterior surface of basal 3/4; tarsus (Fig. 7E) medium brown except little more than basal 2/3 of basitarsus (though base light brown) and basal 1/2 of 2nd tarsomere whitish-yellow; basitarsus (Fig. 7E) narrow, nearly parallel-sided, 6.19 times as long as wide, and 0.70 and 0.58 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 7E) well developed, 1.12 times as long as wide, and 0.48 times as wide as greatest width of basitarsus; pedisulcus (Fig. 7E) well developed. Claw (Fig. 7F) with large basal tooth 0.50 times as long as claw. **Wing.** Length 1.6 mm. Costa with dark brown spinules as well as dark brown hairs except basal portion with patch of yellowish hairs. Subcosta with dark brown hairs except near apex bare. Hair tuft on stem

vein yellowish. Basal portion of radius fully haired. Basal cell absent. **Abdomen.** Basal scale light ochereous, with fringe of yellowish-white fine hairs. Dorsal surface of abdomen light to medium brown, moderately covered with dark brown hairs; tergites of segments 2 and 6–8 shiny; sternal plate on segment 7 undeveloped. **Genitalia.** Sternite 8 (Fig. 7G) bare medially, with 13–16 short to very long stout hairs and few short setae on each side. Ovipositor valves (Fig. 7G) nearly triangular, thin, membranous, moderately covered with microsetae interspersed with 3 or 4 short setae; inner margins slightly sinuous, moderately sclerotized. Genital fork (Fig. 7H) of usual inverted-Y form, with arms of moderate width; arm folded medially, with large projection directed medioposteriorly. Paraproct in ventral view (Fig. 7I) subquadrate, with 15 or 16 long hairs on ventral and lateral surface, and with 5 sensilla on anteromedial surface; paraproct in lateral view (Fig. 7J) about half as long as wide, much produced ventrally beyond ventral margin of cercus. Cercus in lateral view (Fig. 7J) rounded posteriorly, half as long as wide. Spermatheca (Fig. 7K) ellipsoidal, 1.50 times as long as wide, well sclerotized except duct and small area of juncture with duct unsclerotized, and with reticulate pattern on surface near juncture and many fissures on rest of surface; internal setae absent; both accessory ducts slender, very slightly larger in diameter than major one.

**Pupa.** Body length 2.0 mm. **Head.** Integument light yellow, without any tubercles; frons with 3 pairs of simple very long stout trichomes with or without uncoiled apices, all arising close together (Fig. 8A), and face with pair of simple very long stout trichomes with coiled apices (Fig. 8B). **Thorax.** Integument dark yellow, without any tubercle on dorsal and dorsolateral surface of anterior 3/4, sparsely covered with small cone-shaped or round tubercles on dorsal surface of posterior 1/4; thorax with 3 simple very long mediodorsal trichomes with coiled apices (Fig. 8C), 2 simple anterolateral trichomes (1 very long, stout, with coiled apex, 1 medium-long, slender, with uncoiled apex) (Fig. 8D), 1 simple short somewhat stout mediolateral trichome with uncoiled apex (Fig. 8E) and 3 simple short slender ventrolateral trichomes with uncoiled apices (Fig. 8F) on each side. Gill (Fig. 8G) composed of 8 slender thread-like filaments arranged as (2+1)+(2+1)+2 filaments from dorsal to ventral; common basal stalk very short, with round transparent swollen organ ventrally; filaments of dorsal triplet subequal in length (0.6–0.8 mm according to 3 intact filaments (1 left side, 2 right side) of dorsal triplet groups) and thickness, filaments of middle triplet subequal in length (1.1 mm according to 1 intact filament of middle triplet on right side) and thickness, inner filament of ventral paired filaments very slightly thicker than outer filament and their exact length unmeasurable because apical portion of filaments is lost (length of remaining portion of filaments about 1.4 mm); proportional thickness of 8 filaments from dorsal to ventral 0.8:0.8:0.8:0.8:0.8:0.9:1.3:1.4; all filaments light yellow, with well-defined annular ridges and furrows on outer surface, and densely covered with minute tubercles. **Abdomen.** Dorsally, whole of segment 1, most of segments 2 and 9 light yellow, without tubercles; other segments almost transparent; segment 1 with 1 simple medium-long slender seta on each side; segment 2 with 1 simple medium-long slender seta and 5 or 6 very short setae submedially on each side; segments 3 and 4 each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking spine-combs; segments 6–8 each with spine-combs in transverse row and comb-like groups of minute spines on each side; segment 9 with pair of distinct flat terminal hooks (Fig. 8H) and comb-like groups of minute spines on each side. Ventrally, segment 4 with 1 simple hook and few short setae on each side; segment 5 with pair of bifid hooks submedially and few simple slender short setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat spaced from each other and few simple slender short setae on each side; segments 4–8 each with comb-like groups of minute spines. Each side of segment 9 with 2 or 3 grapnel-shaped hooklets. **Cocoon.** Wall-pocket shaped, moderately and neatly woven, thin, not extending ventrolaterally; anterior margin somewhat thickly woven; floor roughly woven; individual threads invisible; 2.0 mm long by 0.8 mm wide.

**Male and mature larva.** Unknown.

**Type specimen.** Holotype female (together with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small, slow-flowing stream (water temperature 19.5°C, exposed to the sun, altitude 1,469 m, 28°24'45.5" N, 83°51'02.0" E), Padhera, Lekhani, Baglung, Nepal, 25.IX.2009.



**FIGURE 7.** Female of *Simulium* (*Gomphostilbia*) *baglungense* **sp. nov.** A, fronto-ocular area (right side; front view); B, 3rd segment of maxillary palp with sensory vesicle (right side; front view); C, upper part of cibarium; D, hind tibia (left side; outer view); E, basitarsus and 2nd tarsomere of hind leg (left side; outer view); F, claw with large basal tooth (lateral view); G, 8th sternite and ovipositor valves (ventral view); H, genital fork (ventral view); I & J, paraproct and cercus (right side; I, ventral view; J, lateral view); K, spermatheca (lateral view). Scale bars. 0.05 mm for D & E; 0.02 mm for A–C & G–K; 0.01 mm for F.

**Biological notes.** The pupa of this new species was collected from a grass leaf trailing in water. No other species was collected.

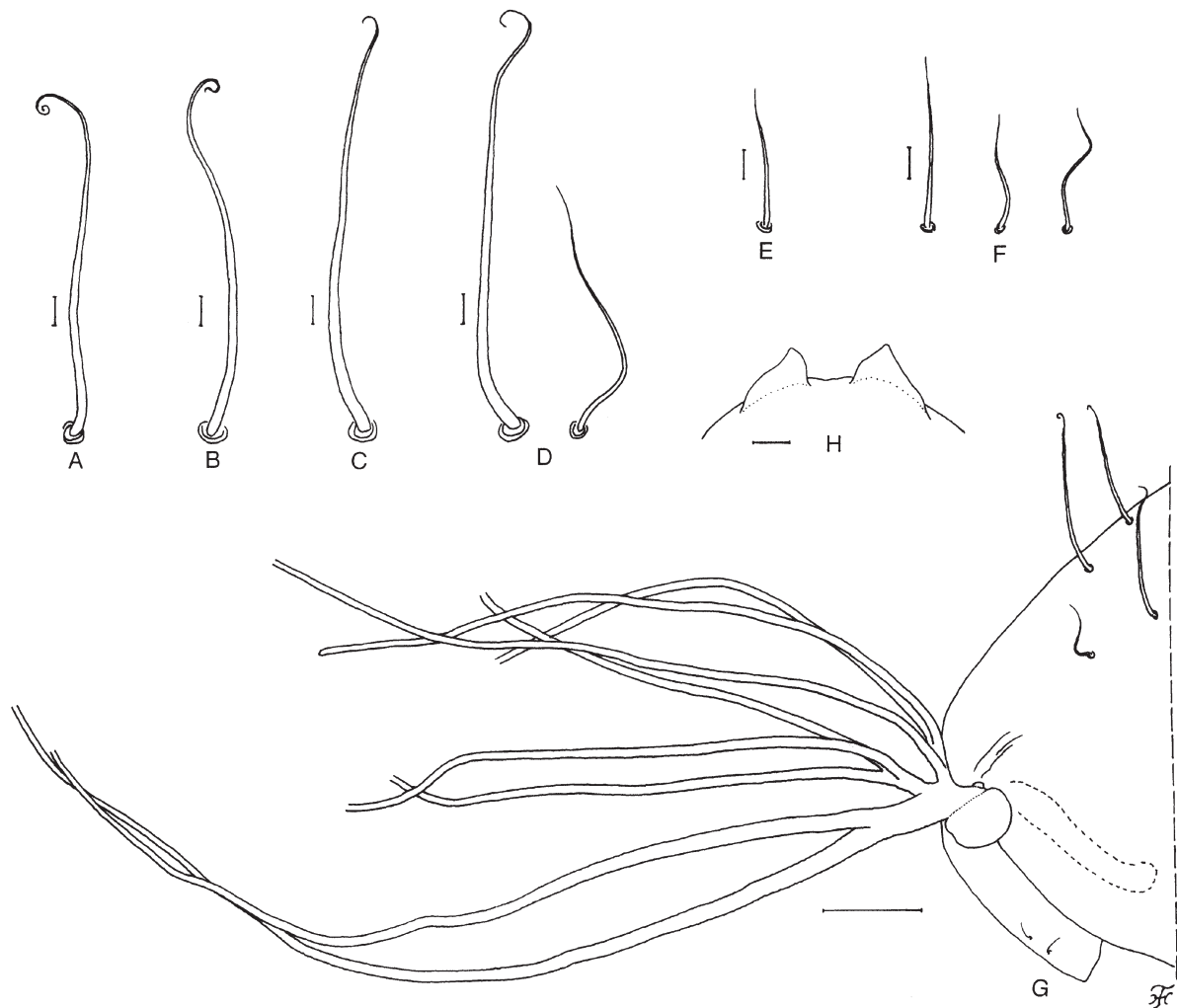
**Etymology.** The species name *baglungense* refers to the locality name, Baglung, where this new species was collected.

**Remarks.** This new species is assigned to either the *batoense* species-group or the *ceylonicum* species-group of the subgenus *Gomphostilbia* in having the antenna with nine flagellomeres, the bare pleural membrane, haired katapisternum and the claw with a large basal tooth (Fig. 7F) in the female and the eight thread-like gill filaments (Fig. 8G) in the pupa.



This new species is characterized by the pupal frons and thorax (except posterior 1/3) with no tubercle and the pupal gill with a relatively large transparent bulb-like organ at its base (Fig. 8G). There is no record of other known *Gomphostilbia* species which lack tubercles on the frons and most of the thoracic integument.

The female of this new species is similar in the leg color to those of *S. (G.) bhutanense* Takaoka & Somboon and *S. (G.) chuzargangense* Takaoka & Somboon, both of which were described from female specimens collected from Bhutan (Takaoka & Somboon 2008). However it is easily distinguished from these known species by the following characteristics: claw with a large basal tooth (claw with a medium-sized basal tooth in *S. (G.) bhutanense*) and by the subcosta which is almost entirely haired (subcosta almost bare in *S. (G.) chuzargangense*).



**FIGURE 8.** Pupa of *Simulium (Gomphostilbia) baglungense* **sp. nov.** A, frontal trichome; B, facial trichome; C–F, thoracic trichomes (C, mediodorsal; D, anterolateral; E, mediolateral; F, ventrolateral); G, anterior part of thorax showing trichomes and gill filaments (left side; outer view); H, terminal hooks (end view). Scale bars. 0.1 mm for G; 0.01 mm for A–F & H.

***Simulium (Gomphostilbia) butwalense* Takaoka & Shrestha **sp. nov.****

**Description. Male.** Body length 2.6 mm. **Head.** Much wider than thorax. Upper eye consisting of 16 vertical columns and 16 horizontal rows of large facets. Face brownish-black, white pruinose, not shiny. Clypeus brownish-black, white pruinose, not shiny, moderately covered with yellow short to medium-long hairs interspersed with several dark brown simple medium-long hairs along each lateral margin. Antenna composed of scape, pedicel and 9 flagellomeres, dark brownish except scape, pedicel and base of 1st flagellomere yellow though apical portion of pedicel somewhat darkened; 1st flagellomere elongate, 1.58 times as long as



2nd one. Maxillary palp with 5 segments, light brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.19:2.77; 3rd segment (Fig. 9A) widened apically; sensory vesicle (Fig. 9A) ellipsoidal, small, 0.21 times as long as 3rd segment, and with small opening. **Thorax.** Brownish-black, whitish-gray pruinose along lateral margins and on anterior and prescutellar areas, covered with yellow scale-like recumbent short hairs (most hairs lost). Scutellum brownish-black (all upright long hairs as well as short hairs lost). Postnotum brownish-black, whitish-gray pruinose and bare. Pleural membrane bare. Katepisternum brownish-black, whitish-gray pruinose, covered with dark short hairs. **Legs.** Foreleg: coxa and trochanter medium brown; femur medium brown with apical cap dark brown (though extreme tip yellowish); tibia dark brown except base yellow and median large portion on outer surface medium brown; tarsus dark brown, with moderate dorsal hair crest; basitarsus somewhat dilated, 7.29 times as long as its greatest width. Midleg: coxa dark brown; trochanter light to medium brown; femur light to medium brown with apical cap dark brown; tibia dark brown except base narrowly yellow; tarsus dark brown. Hind leg: coxa dark brown; trochanter dark yellow; femur medium brown except base dark yellow to light brown and apical cap dark brown; tibia dark brown except base yellow; tarsus (Fig. 9B) medium brown except little more than basal 2/3 of basitarsus (though base light brown) and basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 9B) narrow, nearly parallel-sided (though slightly tapered from apical 1/3 to apex), 6.25 times as long as wide, and 0.59 and 0.53 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 9B) well developed, 1.30 times as long as wide, and 0.46 times as wide as greatest width of basitarsus; pedisulcus (Fig. 9B) well developed. **Wing.** Length 1.6 mm. Costa with dark brown spinules as well as dark brown hairs except basal portion with patch of yellowish hairs. Subcosta without hairs. Hair tuft on stem vein lost. Basal portion of radius fully haired. Basal cell absent. **Abdomen.** Basal scale dark brown, with fringe of yellow long hairs though basal portions somewhat darkened. Dorsal surface of abdomen medium brown except basal 1/2 of segment 2 yellow, covered with dark brown short to long hairs; segments 2 and 5–8 each with pair of shiny dorsolateral or lateral patches, of which those on segment 2 broadly connected in middle to each other. **Genitalia.** Coxite in ventral view (Fig. 9C) nearly rectangular, 1.70 times as long as its greatest width. Style in ventral view (Fig. 9C) slender, tapered toward apex, markedly curved inward, with apical spine; style in ventrolateral view (Fig. 9D) somewhat wide basally (0.45 times as wide as its length), moderately tapered toward basal 1/3, then very slightly tapered toward blunt apex; style in medial view (Fig. 9E) markedly curved mediodorsally. Ventral plate in ventral view (Fig. 9C) transverse, 0.49 times as long as wide, with anterior margin produced anteromedially, posterior margin somewhat concave medially, posterolateral corners angulate, and densely covered with microsetae on ventral surface except anteromedial portion narrowly bare and lateral portions widely bare; basal arms of moderate length, directed forward though slightly converged apically; ventral plate in lateral view (Fig. 9F) nearly flat, not produced ventrally; ventral plate in end view (Fig. 9G) gently curved ventrally, moderately covered with microsetae on ventral 1/2 of posterior surface except both lateral areas mostly bare; ventral margin slightly concave ventromedially. Median sclerite (Fig. 9F,H) thin, plate-like, wide, connected to anterior 1/5 of ventral plate. Paramere (Fig. 9I) slender, with 8 small to long distinct hooks and few much smaller ones directed dorsally near apex. Aedeagal membrane densely setose, not sclerotized. Ventral surface of 10th abdominal segment without distinct hairs near posterior margin on each side. Cercus (Fig. 9J,K) not well defined, with 7 or 9 hairs.

**Pupa.** Body length 2.8 mm. **Head.** Integument dark yellow, moderately covered with round small tubercles; antennal sheath without tubercle; frons with 3 pairs of simple very long trichomes with coiled or uncoiled apices (Fig. 10A), all arising close together, and face with pair of simple very long trichomes (Fig. 10B) (tip lost, then not known whether apex is coiled or uncoiled). **Thorax.** Integument dark yellow, sparsely covered with round small tubercles; thorax with 3 very long mediodorsal trichomes with coiled apices (Fig. 10C) (though 1 of 3 trichomes on right side medium-long and with uncoiled apex—Fig. 10D), 2 anterolateral trichomes (1 very long and with coiled apex, 1 medium-long and with uncoiled apex) (Fig. 10E), 1 medium-long simple mediolateral trichome (Fig. 10F) and 3 simple ventrolateral trichomes (1 long, 2 medium-long) (Fig. 10G) on each side. Gill (Fig. 10H,I) composed of 8 thread-like filaments arranged from dorsal to ventral as  $[2+1+(1+2)]+2$  filaments in right gill (Fig. 10H) or  $\{2+[1+(1+2)]\}+2$  filaments in left gill (Fig. 10I) of holotype male pupal exuviae, or  $[(2+1)+(1+2)]+2$  filaments in both right and left gills of female pupal exuviae (arrangement and relative thickness of filaments very similar to those of right gill of holotype male pupal exuviae—Fig. 10H); common basal stalk very short, with round transparent swollen organ ventrally; apical portions of all filaments lost, so their exact lengths unmeasurable (though length of remaining portion of inner filament of ventral pair about 1.5 mm); thickness of 8 filaments variable apparently among filaments and also,

though slightly, between right and left gills, with inner (or ventral) filament of ventral pair and inner (or ventral) filament of middle pair apparently thicker than other remaining filaments which are subequal in thickness to one another, i.e., proportional thickness of basal portions of 8 filaments from dorsal to ventral 1.00:1.00:1.17:1.17:1.00:1.50:1.17:1.50 in right gill (Fig. 10H) and 1.00:1.00:1.00:1.00:1.00:1.33:1.17:1.50 in left gill (Fig. 10I); all filaments light yellow, with well-defined annular ridges and furrows on outer surface, and densely covered with minute tubercles. **Abdomen.** Dorsally, segments 1, 2 and 9 light yellow, without tubercles; other segments almost transparent; segment 1 with 1 medium-long simple seta (Fig. 10J) on each side; segment 2 with 1 medium-long simple seta and 5 very short setae (Fig. 10K) submedially on each side; segments 3 and 4 each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking spine-combs; segments 6–9 each with spine-combs in transverse row and comb-like groups of minute spines on each side; segment 9 with pair of distinct triangular terminal hooks when viewed from posteriorly (Fig. 10L). Ventrally, segment 4 with 1 simple hook and few short setae on each side; segment 5 with pair of bifid hooks submedially and few simple slender short setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat spaced from each other and few simple slender short setae on each side; segments 4–8 each with comb-like groups of minute spines. Each side of segment 9 with 3 grapple-shaped hooklets. **Cocoon.** Wall-pocket shaped, thinly woven, slightly extending ventrolaterally; anterior margin not thickly woven; floor roughly or moderately woven; individual threads invisible; 2.4 mm long by 1.2 mm wide.

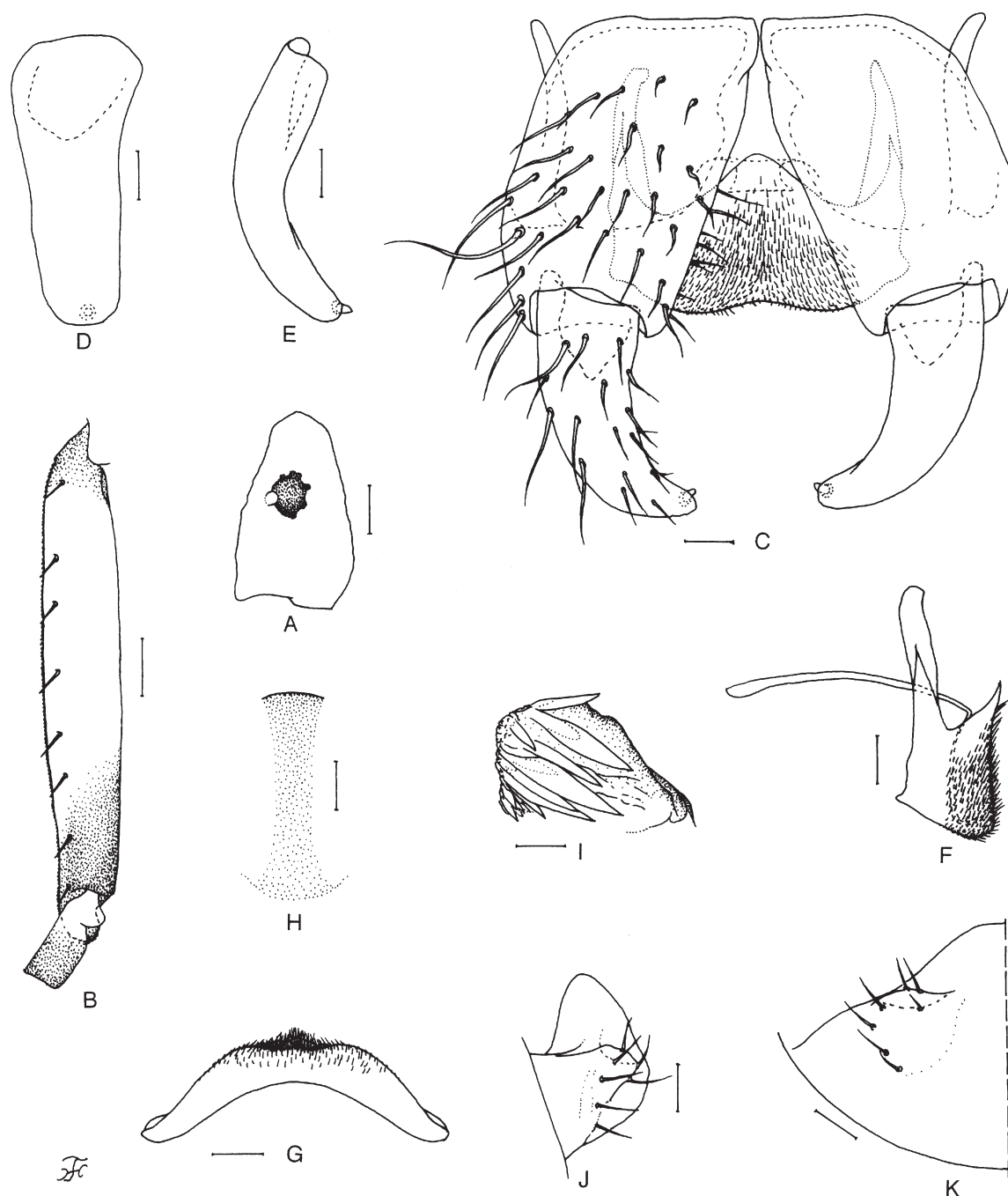
**Mature larva.** Body length 4.0 mm. Body yellowish. Head capsule moderately covered with simple minute setae. Cephalic apotome whitish-yellow on anterior 1/2 and dark yellow on posterior 1/2; spots not well defined though anterior spot of mediolongitudinal spots and posterolateral spots faintly positive. Lateral surface of head capsule mostly dark yellowish except eye-spot region white; 2 large spots and 1 small spot in front of posterior margin on both sides faintly positive, and 2 small spots below eye-spot region on left side faintly positive but those spots on right side indistinct. Ventral surface of head capsule (Fig. 11A) dark yellow, with dark brown area on each side of postgenal cleft; elongate spots on each side of postgenal cleft indistinct. Cervical sclerites composed of 2 small light brown rod-like pieces, not fused to occiput, widely separated from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; antenna pale except most of dorsal surface of 1st segment brownish; proportional lengths of 1st, 2nd, and 3rd segments 1.0:1.1:0.8. Labral fan with 29 main rays. Mandible (Fig. 11B,C) with 2 comb-teeth (though 3rd tooth appearing to be broken and lost in left mandible); 1st tooth much longer than 2nd one; mandibular serrations composed of 2 teeth (1 large and 1 small) (though lost in right mandible); large tooth at acute angle to mandible on apical side. Hypostoma (Fig. 11D) with row of 9 apical teeth, median tooth and corner teeth prominent; lateral margins smooth; hypostomal bristles 4 or 5 in row, parallel to lateral margin on each side. Postgenal cleft (Fig. 11A) long, nearly reaching posterior margin of hypostoma; subesophageal ganglion unpigmented, not visible. Histoblast of pharate pupal gill with 8 thread-like slender filaments, their arrangement being similar to that of right gill of pupa (Fig. 10H). Thoracic cuticle sparsely covered with fine setae (simple or with 2–8 branches) dorsally. Abdominal cuticle moderately (on segments 1–3) and densely (on segments 4–9) covered with fine setae with 2–9 branches (mostly 6–8 branches) (Fig. 11E) dorsally, dorsolaterally, and laterally (on segments 5–9); both sides of anal sclerite densely covered with fine similar branched setae as well as colorless simple setae. Rectal scales present. Rectal organ compound, each of 3 lobes with 7 or 8 finger-like secondary lobules. Anal sclerite X-shaped, anterior arms 0.88 times as long as posterior ones; accessory sclerites absent; sensillum absent. Ventral papillae well developed, conical in shape. Posterior circlet with 80 rows of up to 16 hooks per row.

**Female:** Unknown

**Type specimens.** Holotype male (together with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small, rapid-flowing stream (water temperature 15.0°C, exposed to the sun, altitude 241 m, 27°43'90.1" N, 83°28'17.6" E), Shidhdhababa, near the gate to Palpa, Butwal, Nepal, 25.IX.2009. Paratypes: 1 female pupal exuviae and 1 mature larva, same date and data as those of the holotype.

**Biological notes.** The pupa and larva of this new species were collected from grass leaves trailing in water. No other species was collected.

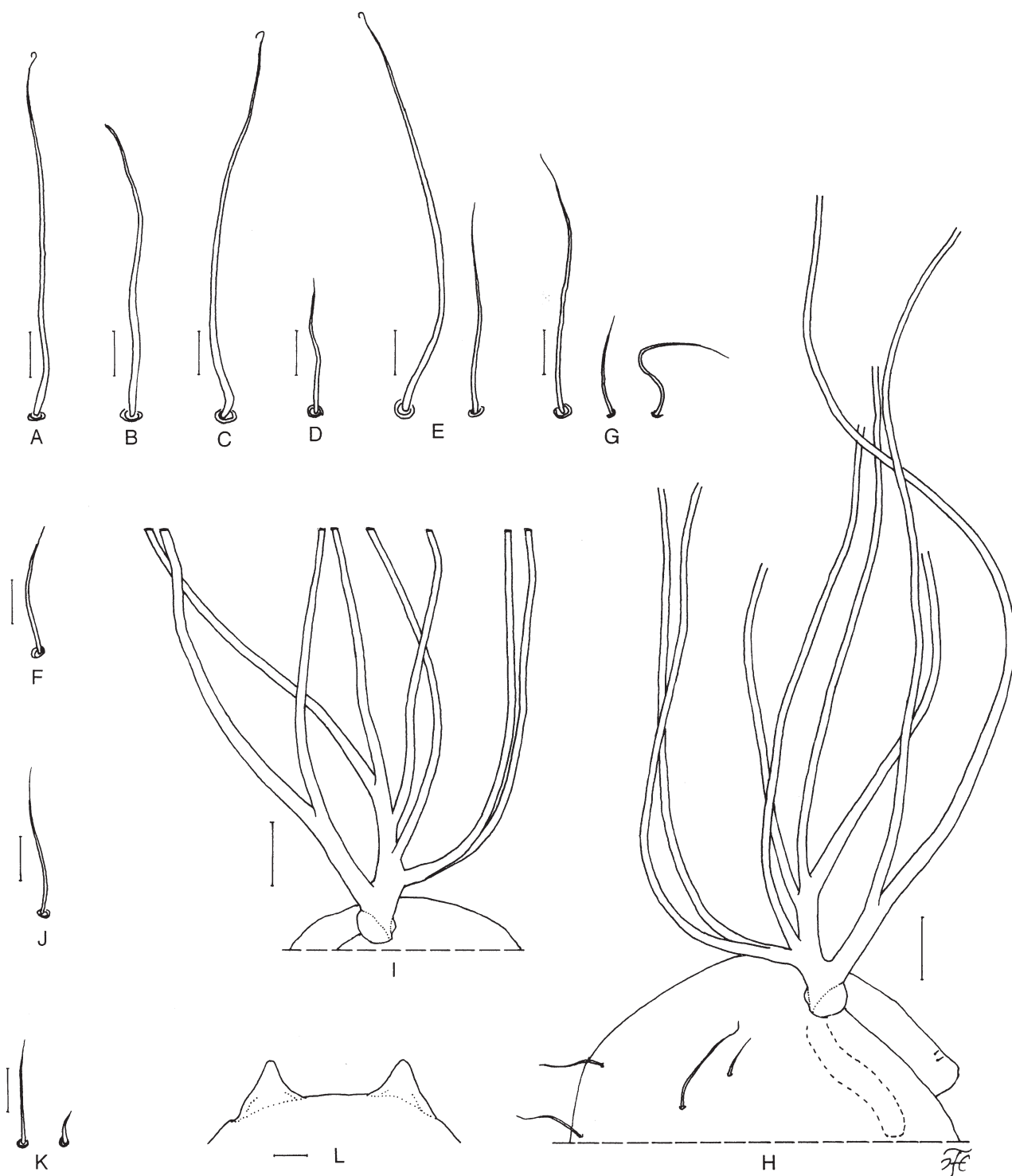
**Etymology.** The species name *butwalense* refers to the locality name, Butwal, where this new species was collected.



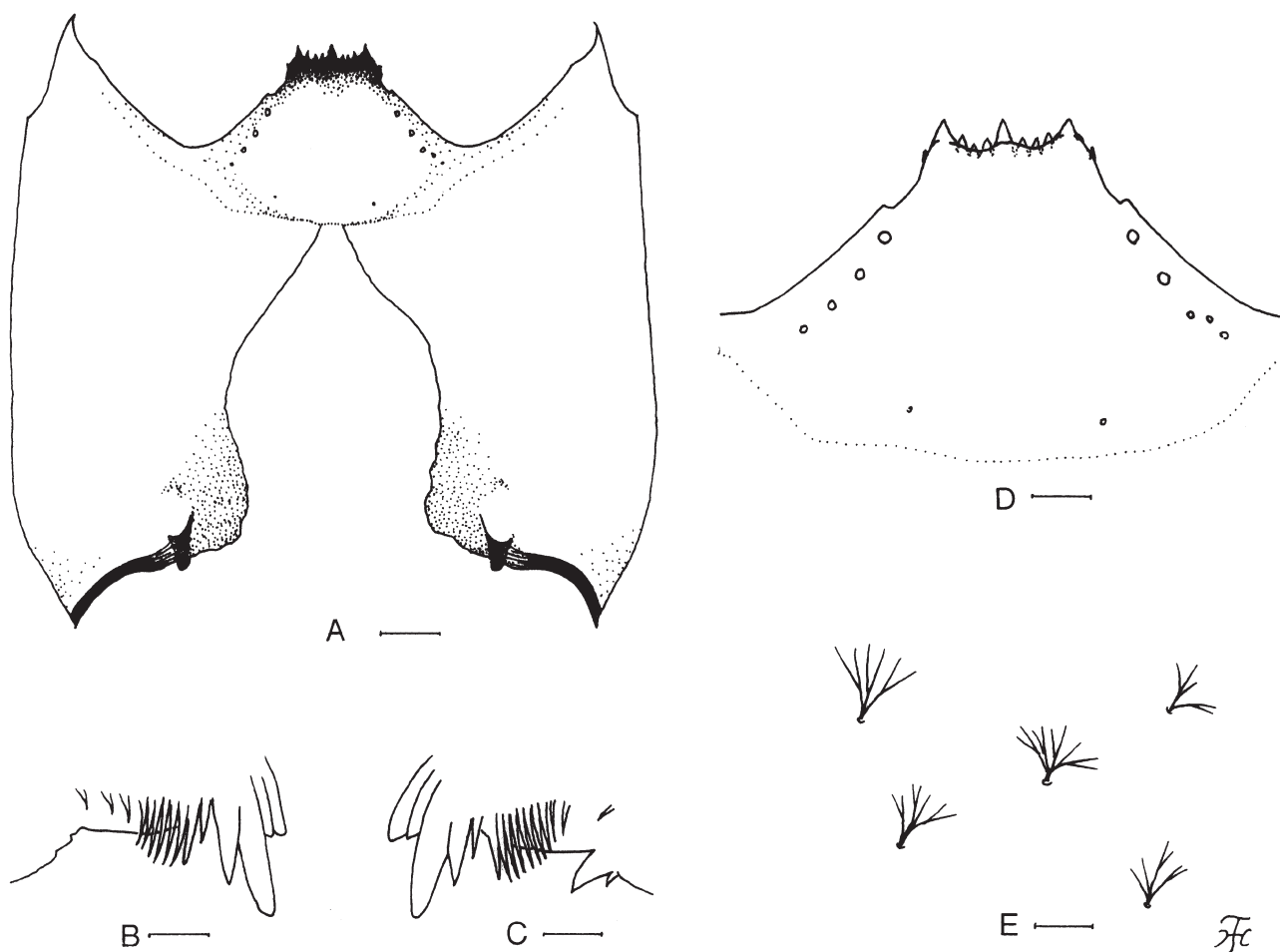
**FIGURE 9.** Male of *Simulium (Gomphostilbia) butwalense* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (left side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D & E, style (right side; D, ventrolateral view; E, medial view); F, ventral plate and median sclerite (lateral view); G, ventral plate (end view); H, median sclerite (end view); I, paramere with many hooks (left side; posterodorsal view); J & K, 10th abdominal segment with cercus (right side; J, lateral view; K, end view). Scale bars. 0.05 mm for B; 0.02 mm for A & C–K.

**Remarks.** This new species is assigned to the *batoense* species-group of the subgenus *Gomphostilbia* in having the antenna with nine flagellomeres, the bare pleural membrane, the haired katapisternum, the slender hind basitarsus (Fig. 9B) in the male and the eight thread-like filaments (Fig. 10H,I) in the pupa.

This new species is characterized by the male ventral plate which is not markedly produced ventrally and nearly flat (Fig. 9G) combined with the relative thickness of the eight pupal gill filaments, of which an inner filament of both ventral and middle pairs are apparently thicker than the other six filaments (Fig. 10H, I), and the simple triangular terminal hooks (Fig. 10L). There is no known species which bears a similar combination of the characteristics.



**FIGURE 10.** Pupa of *Simulium (Gomphostilbia) butwalense* **sp. nov.** A, frontal trichome; B, facial trichome (tip lost); C–G, thoracic trichomes (C & D, mediodorsal; E, anterolateral; F, mediolateral; G, ventrolateral); H, anterior part of thorax showing trichomes and gill filaments (apical parts of all filaments lost) (right side; outer view); I, gill filaments showing arrangement differing from that of right gill filaments of same pupa (left side; outer view); J, slender seta on dorsal surface of abdominal segment 1; K, slender seta and 1 of 5 very short spinous setae on dorsal surface of abdominal segment 2; L, terminal hooks (end view). Scale bars. 0.1 mm for H & I; 0.02 mm for A–G, J & K; 0.01 mm for L.



**FIGURE 11.** Mature larva of *Simulium (Gomphostilbia) butwalense* sp. nov. A, head capsule showing long postgenal cleft (ventral view); B & C, apical portion of mandible (B, right side; C, left side); D, hypostoma; E, fine branched setae on dorsal surface of abdominal segment 8. Scale bars. 0.04 mm for A; 0.02 mm for D; 0.01 mm for B, C & E.

***Simulium (Gomphostilbia) nuwakotense* Takaoka & Shrestha sp. nov.**

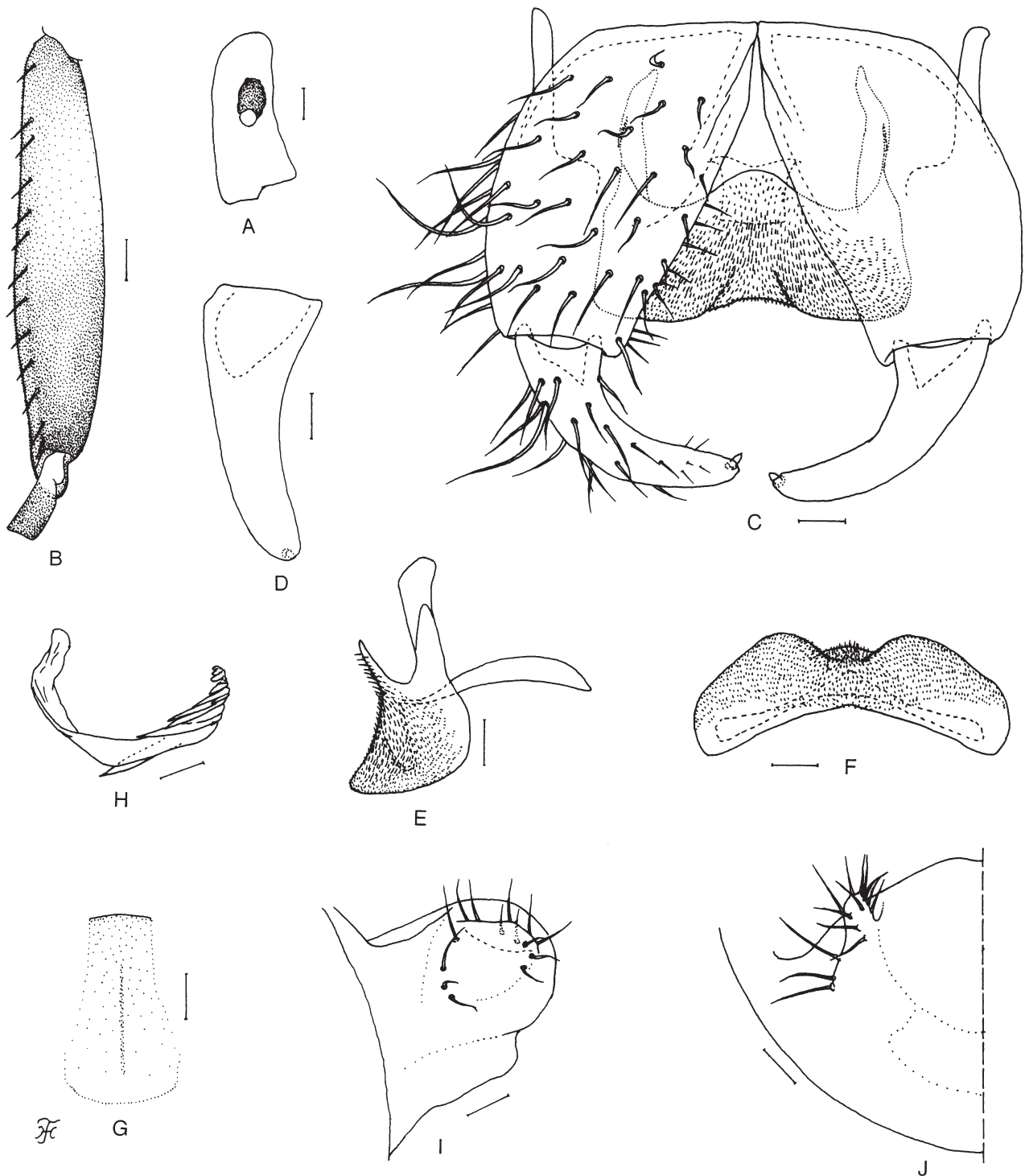
**Description. Male.** Body length 2.5 mm. **Head.** Much wider than thorax. Upper eye consisting of 17 vertical columns and 18 horizontal rows of large facets. Face and clypeus dark brown, white pruinose, silvery-iridescent when illuminated at certain angle of light; clypeus densely covered with yellowish-white short to medium-long hairs interspersed with several dark brown simple medium-long hairs. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown except scape, pedicel and base of 1st flagellomere yellow though parts of scape somewhat darkened; 1st flagellomere elongate, 1.78 times as long as 2nd one. Maxillary palp with 5 segments, light brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:1.18:2.68; 3rd segment (Fig. 12A) somewhat widened near apex; sensory vesicle (Fig. 12A) ellipsoidal, small, 0.29 times as long as 3rd segment, and with medium-sized opening apically. **Thorax.** Brownish-black to black, covered with yellowish-white short hairs (most hairs lost); scutum whitish-gray pruinose and shiny widely along lateral margins and on anterior and prescutellar areas when illuminated at certain angle of light. Scutellum dark brown, with yellowish-white short hairs (all upright long hairs as well as most short hairs lost). Postnotum dark brown, whitish-gray pruinose and bare. Pleural membrane bare. Katepisternum brownish-black, whitish-gray pruinose, covered with yellow short hairs as well as dark short hairs. **Legs.** Foreleg: coxa dark yellow to light brown; trochanter medium brown; femur medium brown with apical cap dark brown; tibia dark brown except median large portion on outer surface medium brown; tarsus dark brown, with moderate dorsal hair crest; basitarsus somewhat dilated, 7.22 times as long as its greatest width. Midleg: coxa dark brown; trochanter light to medium brown; femur medium brown with apical cap dark brown; tibia dark



brown except basal 1/4 or little more yellow; tarsus dark brown. Hind leg: coxa medium to dark brown; trochanter light brown; femur medium brown except apical cap dark brown; tibia dark brown except from base to basal 1/5 yellow and from basal 1/5 to basal 2/5 light brown; tibia covered with yellow hairs on basal 2/5; tarsus (Fig. 12B) medium brown except basal 1/2 of basitarsus (though base and narrow area along anterior margin medium brown) dark yellow to light brown and little less than basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 12B) somewhat swollen, spindle-shaped, 4.72 times as long as wide, and 0.78 and 0.75 times as wide as greatest width of tibia and femur, respectively; calcipala (Fig. 12B) well developed, 1.10 times as long as wide, and 0.35 times as wide as greatest width of basitarsus; pedisulcus (Fig. 12B) well developed. **Wing.** Length 2.0 mm. Costa with dark brown spinules as well as dark brown hairs except basal portion with patch of yellowish hairs. Subcosta without hairs. Hair tuft on stem vein yellow. Basal portion of radius fully haired. Basal cell absent. **Abdomen.** Basal scale dark brown, with fringe of light brown long hairs. Dorsal surface of abdomen medium to dark brown except basal 1/2 of segment 2 yellow, covered with dark brown short to long hairs; segments 2 and 5–9 each with pair of shiny dorsolateral or lateral patches, of which those on segment 2 broadly connected in middle to each other. **Genitalia.** Coxite in ventral view (Fig. 12C) nearly rectangular, 1.78 times as long as its greatest width. Style in ventral view (Fig. 12C) slender, tapered toward apex, markedly curved inward, with apical spine; style in ventrolateral view (Fig. 12D) 0.77 times as long as coxite, somewhat wide basally (0.41 times as wide as its length), moderately tapered toward basal 1/2, then very slightly tapered toward apex. Ventral plate in ventral view (Fig. 12C) transverse, 0.50 times as long as wide, slightly widened posteriorly, with anterior margin produced anteromedially, posterior margin somewhat concave medially (though nearly straight when viewed somewhat obliquely), and densely covered with microsetae on ventral surface; basal arms of moderate length, directed forward though slightly convergent apically; ventral plate in lateral view (Fig. 12E) moderately produced ventrally; ventral plate in end view (Fig. 12F) gently curved ventrally, with marked depression medially on ventral margin, densely covered with microsetae on posterior surface except both lateral areas mostly bare on dorsal 1/2. Median sclerite (Fig. 12C,E,G) thin, plate-like, wide, connected to anterior 1/3 of ventral plate. Paramere (Fig. 12H) slender, with several distinct hooks decreasing in length toward base. Aedeagal membrane densely setose, not sclerotized. Ventral surface of 10th abdominal segment somewhat sclerotized near base, without distinct hairs near posterior margin on each side. Cercus (Fig. 12I,J) somewhat produced posteroventrally, with 14 or 15 hairs.

**Pupa.** Body length 3.0 mm. **Head.** Integument yellow, moderately covered with round tubercles except antennal sheath without tubercles; frons with 3 simple very long trichomes on each side; face with 1 simple or bifid very long trichome on each side; frontal trichomes slightly longer than facial ones. **Thorax.** Integument yellow to dark yellow, moderately covered with round tubercles, with 3 simple long trichomes with coiled or uncoiled apices dorsomedially, 2 simple trichomes (1 very long, 1 long) with uncoiled apices anterolaterally, 1 simple long trichome with uncoiled apex mediolaterally, and 3 simple trichomes with uncoiled apex (1 medium-long, 2 short) ventrolaterally on each side. Gill (Fig. 13A,B) of inflated Y-form in lateral view (0.7–0.8 mm long), each arm short (dorsal arm 0.3 mm long, ventral arm 0.4 mm long), with 2 short finger-like projections (0.13–0.19 mm long), 1 very short nipple-like one (0.02–0.05 mm long) and 1 thread-like filament (0.5–0.6 mm long); in addition, 6 slender thread-like filaments (2 individual and 4 paired filaments, arranged as 1+2+1+2 from dorsal to ventral) arising near base from inside surface; all 6 thread-like filaments subequal in length (0.8–0.9 mm) and thickness to one another; each inflated arm with 2 constrictions; cuticle of inflated structure grayish except basal portion blackish dorsally, very thick except somewhat swollen thin transparent organ ventrally (mostly broken) at base; cuticle of 8 thread-like filaments as well as that of inflated structure smooth and densely covered with very minute tubercles. **Abdomen.** Dorsally, all segments almost transparent except segment 9 yellowish; segments 1 and 2 without tubercles; segment 1 with 1 medium-long simple seta on each side; segment 2 with 1 medium-long simple seta and 5 very short setae submedially on each side; segments 3 and 4 each with 4 hooked spines and 1 very short seta on each side; segment 5 lacking spine-combs; segments 6–9 each with spine-combs in transverse row (though those on segment 9 much smaller than others on other segments) and comb-like groups of minute spines on each side; segment 9 with pair of distinct plate-like wide terminal hooks with crenulated outer margin (Fig. 13C). Ventrally, segment 4 with 1 simple hook and few short setae on each side; segment 5 with pair of bifid hooks submedially and few simple slender short setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat

spaced from each other and few simple slender short setae on each side; segments 4–8 each with comb-like groups of minute spines. Each side of segment 9 with 3 grapple-shaped hooklets. **Cocoon.** Wall-pocket shaped, thinly woven, moderately extending ventrolaterally; anterior margin somewhat thickly woven; floor roughly or moderately woven; individual threads invisible; 3.5 mm long by 2.2 mm wide.



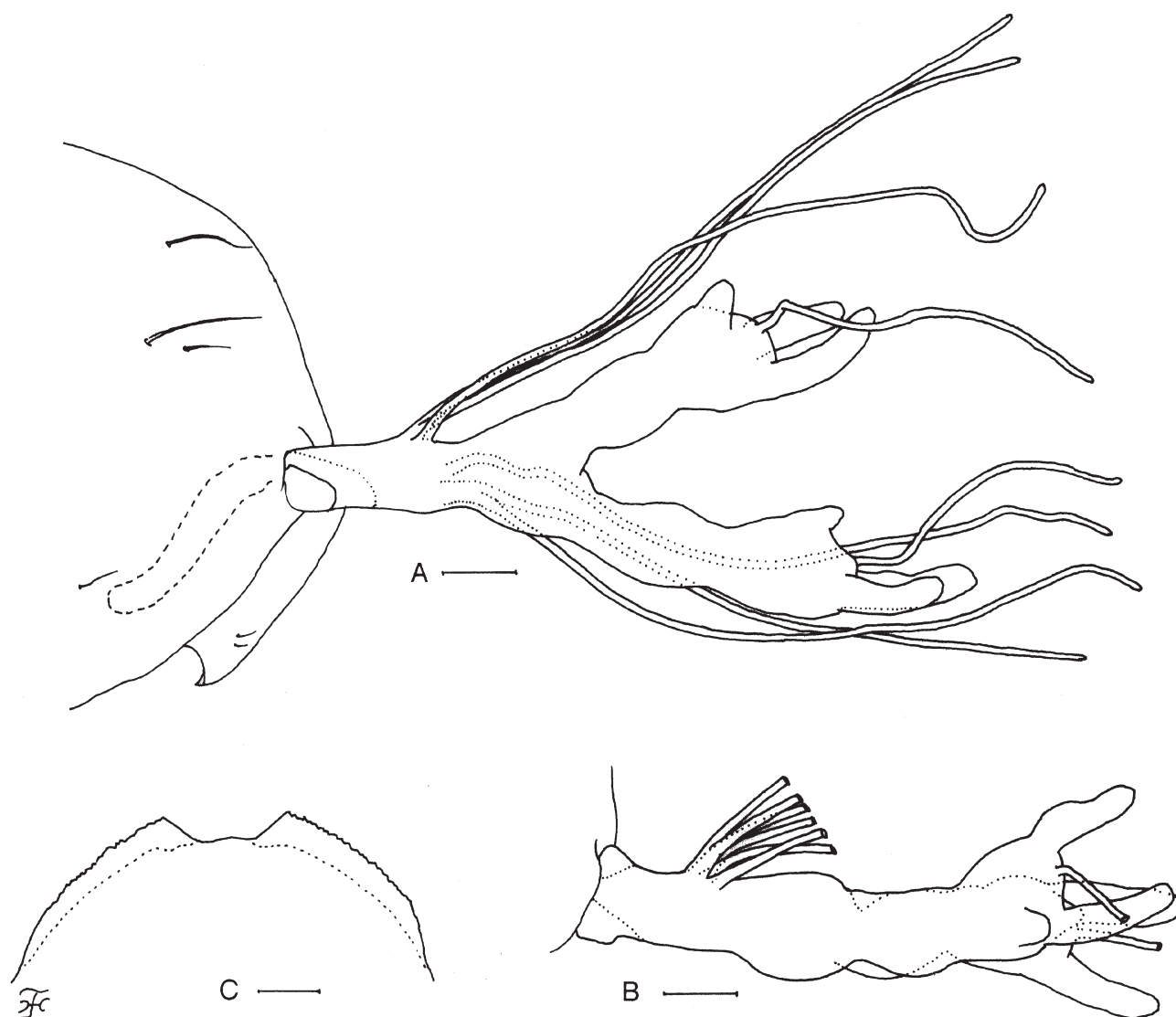
**FIGURE 12.** Male of *Simulium* (*Gomphostilbia*) *nuwakotense* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (right side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D, style (right side; ventrolateral view); E, ventral plate and median sclerite (lateral view); F, ventral plate (end view); G, median sclerite (end view); H, paramere with several hooks (left side; dorsal view); I & J, 10th abdominal segment with cercus (right side; I, lateral view; J, end view). Scale bars. 0.05 mm for B; 0.02 mm for A & C–J.

**Female and mature larva.** Unknown.

**Type specimen.** Holotype male (together with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small stream (water temperature 23.0°C, exposed to the sun, altitude 1,811 m, 27°81'05.7" N, 85°25'64.5" E) rapidly flowing along the road, near Ranipauwa, Nuwakot, Nepal, 5.VIII.2009.

**Biological notes.** The pupa of this new species was collected from a grass leaf trailing in water. No other species was collected.

**Etymology.** The species name *nuwakotense* refers to the locality name, Nuwakot, where this new species was collected.



**FIGURE 13.** Pupa of *Simulium (Gomphostilbia) nuwakotense* **sp. nov.** A, anterior part of thorax showing trichomes and gill composed of inflated portions and slender filaments (right side; outer view); B, gill (right side; dorsal view); C, terminal hooks (end view). Scale bars. 0.1 mm for A & B; 0.02 mm for C.

**Remarks.** The remarkable configuration of the pupal gill of *S. (G.) nuwakotense* **sp. nov.** (Fig. 13A,B) appears to be very similar to those of *S. (G.) gombakense* Takaoka & Davies, originally described from Peninsular Malaysia (Takaoka & Davies 1995; Takaoka 2000) and later recorded from Thailand (Kuvangkadilok & Takaoka 2000), and *S. (G.) sachini* Takaoka & Henry, originally described from Darjeeling, India (Takaoka *et al.* 2010), and newly recorded from Nepal, as noted in the present paper. However, this new species is distinguished in the pupa from these two known species by the dorsal inflated

arm with two constrictions and both dorsal and ventral arms each with one small nipple-like projection as well as two short finger-like projections (dorsal arm with no constriction in *S. (G.) gombakense* and one constriction in *S. (G.) sachini*, and both arms with three short finger-like projections of similar length in both known species).

The male of *S. (G.) nuwakotense* **sp. nov.** is readily distinguished from that of *S. (G.) gombakense* by the ventral plate with two ventrally produced processes (Fig. 12F) but almost indistinguishable from that of *S. (G.) sachini*, though the hind basitarsus of this new species is somewhat narrower than that of *S. (G.) sachini*, as noted under the following species.

### *Simulium (Gomphostilbia) sachini* Takaoka & Henry, 2010

*Simulium (Gomphostilbia) sachini* Takaoka & Henry, 2010: 108–110 (pupa only).

*Simulium (Gomphostilbia) gombakense* (*nec* Takaoka & Davies, 1995): Shrestha & Takaoka 2009: 254 (pupa, misidentification).

This species was recently described from a unique pupal specimen collected in Darjeeling, India (Takaoka *et al.* 2010). As noted under *S. (G.) nuwakotense* **sp. nov.**, this species seems to be closely related to both *S. (G.) nuwakotense* **sp. nov.** and *S. (G.) gombakense* in having the similar characteristic pupal gills.

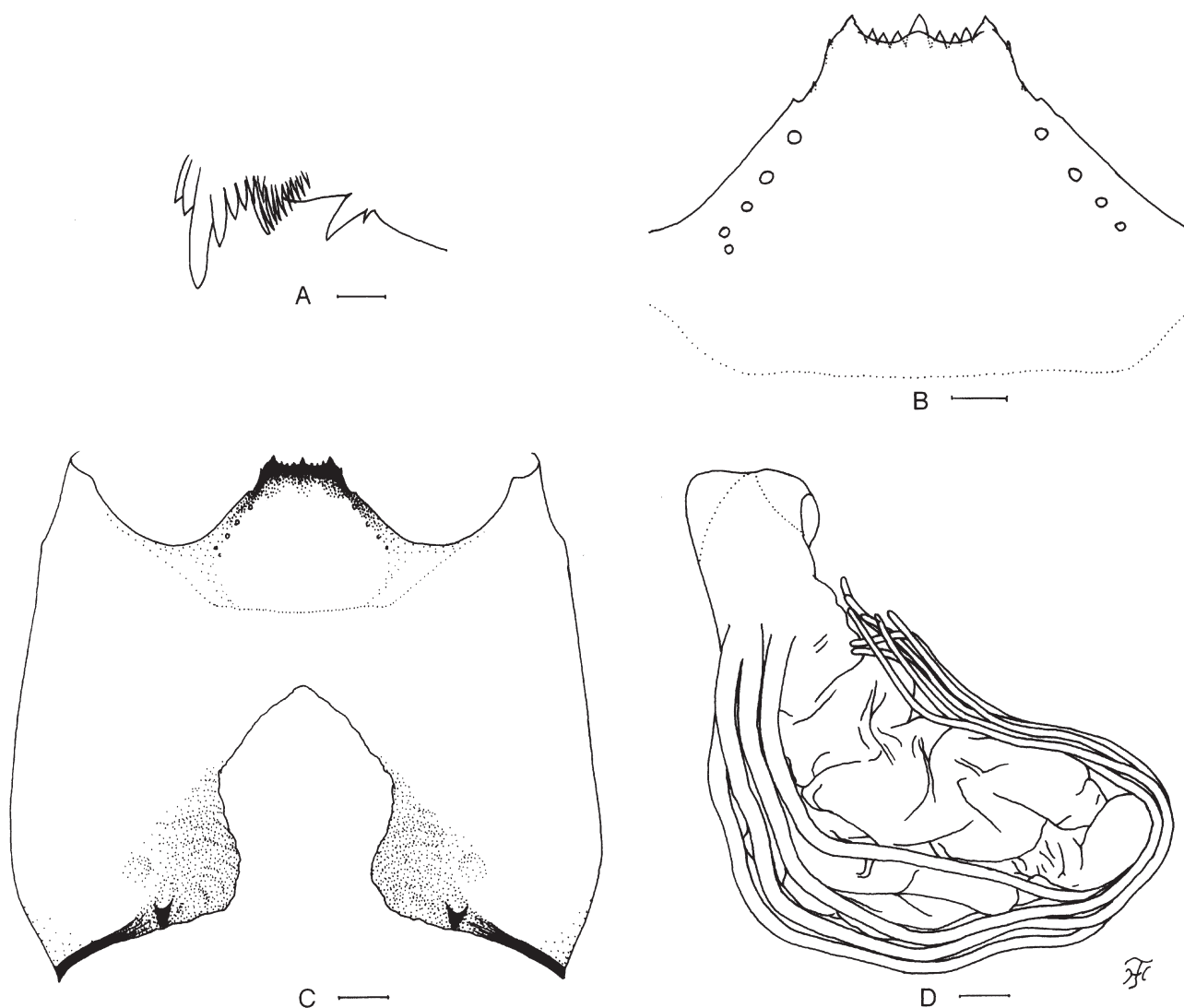
In this study, three males reared from pupae collected from Nepal were identified as *S. (G.) sachini* on the basis of the characteristic configuration of the pupal gill. It should be noted that one of the three specimens examined was the same as previously regarded as *S. (G.) gombakense* by Shrestha & Takaoka (2009). For this reason, a previous record of *S. (G.) gombakense* from Nepal should be corrected.

The male and mature larva of *S. (G.) sachini* are here described for the first time.

**Description. Male.** Nearly as in male of *S. (G.) nuwakotense* **sp. nov.** except following features: Body length 2.5–3.0 mm. **Head.** Antenna dark brown except scape, basal 1/2 of pedicel and base of 1st flagellomere yellow; 1st flagellomere 1.72 times as long as 2nd one. Maxillary palp: Proportional lengths of 3rd, 4th, and 5th segments 1.00:1.06:2.29; sensory vesicle ellipsoidal, small, 0.24 times as long as 3rd segment. **Thorax.** Scutum densely covered with golden yellow short hairs. Scutellum with golden yellow short hairs and dark brown upright longer hairs. **Legs.** Foreleg: basitarsus 7.63–7.78 times as long as its greatest width. Hind leg: basitarsus somewhat swollen, spindle-shaped, 4.05–4.35 times as long as wide, and 0.80–0.84 and 0.80–0.83 times as wide as greatest width of tibia and femur, respectively; calcipala well developed, 1.17 times as long as wide, and 0.33 times as wide as greatest width of basitarsus. **Genitalia.** Coxite in ventral view nearly rectangular, 1.71 times as long as its greatest width. Style in ventrolateral view 0.86 times as long as coxite. Ventral plate in ventral view transverse, 0.47 times as long as wide. Cercus with 13–15 hairs.

**Mature larva.** Body length 5.0–5.3 mm. Body light yellow except dorsal surface of abdominal segments 7 and 8 reddish-brown. Head capsule very sparsely covered with simple minute setae. Cephalic apotome yellow, with faint positive head spots, or somewhat dark yellow on posterior 1/2, thus head spots obscured. Lateral surface of head capsule yellowish or dark yellow except eye-spot region white; spots in front of posterior margin faintly positive; eyebrow indistinct though 1 dark small round spot visible above eye-spot region. Ventral surface of head capsule yellow to dark yellow, with dark brown area on each side of postgenal cleft; elongate spots on each side of postgenal cleft indistinct. Cervical sclerites composed of 2 small light brown rod-like pieces, not fused to occiput, widely separated from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; antenna pale except dorsal surface of basal portion of 1st segment brownish; proportional lengths of 1st, 2nd, and 3rd segments 1.00:0.75–0.84:0.81–0.84. Labral fan with 25–28 main rays. Mandible (Fig. 14A) with 3 comb-teeth (plus additional 2 teeth) decreasing in length from 1st to 3rd though 2nd tooth only slightly longer than 3rd one; mandibular serrations composed of 2 teeth (1 large and 1 small); large tooth at acute angle to mandible on apical side. Hypostoma (Fig. 14B) with row of 9 apical teeth, median tooth and corner teeth prominent; lateral margins smooth; hypostomal bristles 4 or 5 in row, parallel to lateral margin on each side. Postgenal cleft (Fig. 14C) arrow-head shaped, medium-long, 2.6–3.2 times as long as postgenal bridge; subesophageal ganglion

unpigmented, not visible. Pharate pupal gill (Fig. 14D) with wrinkled enlarged body with 6 short finger-like projections and 8 long slender thread-like filaments. Thoracic cuticle bare. Abdominal cuticle bare except both sides of anal sclerite (down to base of ventral papillae) densely covered with colorless simple setae. Rectal scales appearing to be absent. Rectal organ compound, each of 3 lobes with 9–11 finger-like secondary lobules. Anal sclerite X-shaped, anterior arms nearly as long as posterior ones; accessory sclerites absent; sensillum absent. Ventral papillae well developed, conical in shape. Posterior circlet with 84–88 rows of up to 14 hooks per row.



**FIGURE 14.** Mature larva of *Simulium (Gomphostilbia) sachini* Takaoka & Henry. A, apical portion of mandible; B, hypostoma; C, head capsule showing medium-long postgenal cleft (ventral view); D, histoblast of pharate pupal gill (left side; outer view). Scale bars. 0.04 mm for C & D; 0.02 mm for B; 0.01 mm for A.

**Specimens examined.** One male (together with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small stream (water temperature 18.5°C, partially shaded, altitude 1,627 m, 27°96'12.9" N, 85°95'66.8" E) moderately flowing along the road, Kodari, Nepal, 16.VII.2009; 1 male (together with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa, and 1 mature larva collected from a small water canal (water temperature 20.0°C, partially shaded, altitude 1,576 m, 27°95'66.2" N, 85°95'51.4" E) moderately flowing along the road, Tatopani, Nepal, 16.VII.2009; 1 male (together with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small stream (altitude 1,600 m), Shivapuri National Park, Nepal, 9.IV.2008 (previously misidentified as *S. (G.) gombakense*).



**Biological notes.** The pupae and larva of *S. (G.) sachini* were collected from grass leaves trailing in water. Six larvae of *S. (Montisimulium)* sp. and five larvae of *S. (Simulium) tuberosum* species-group were collected from the same stream in Tatopani.

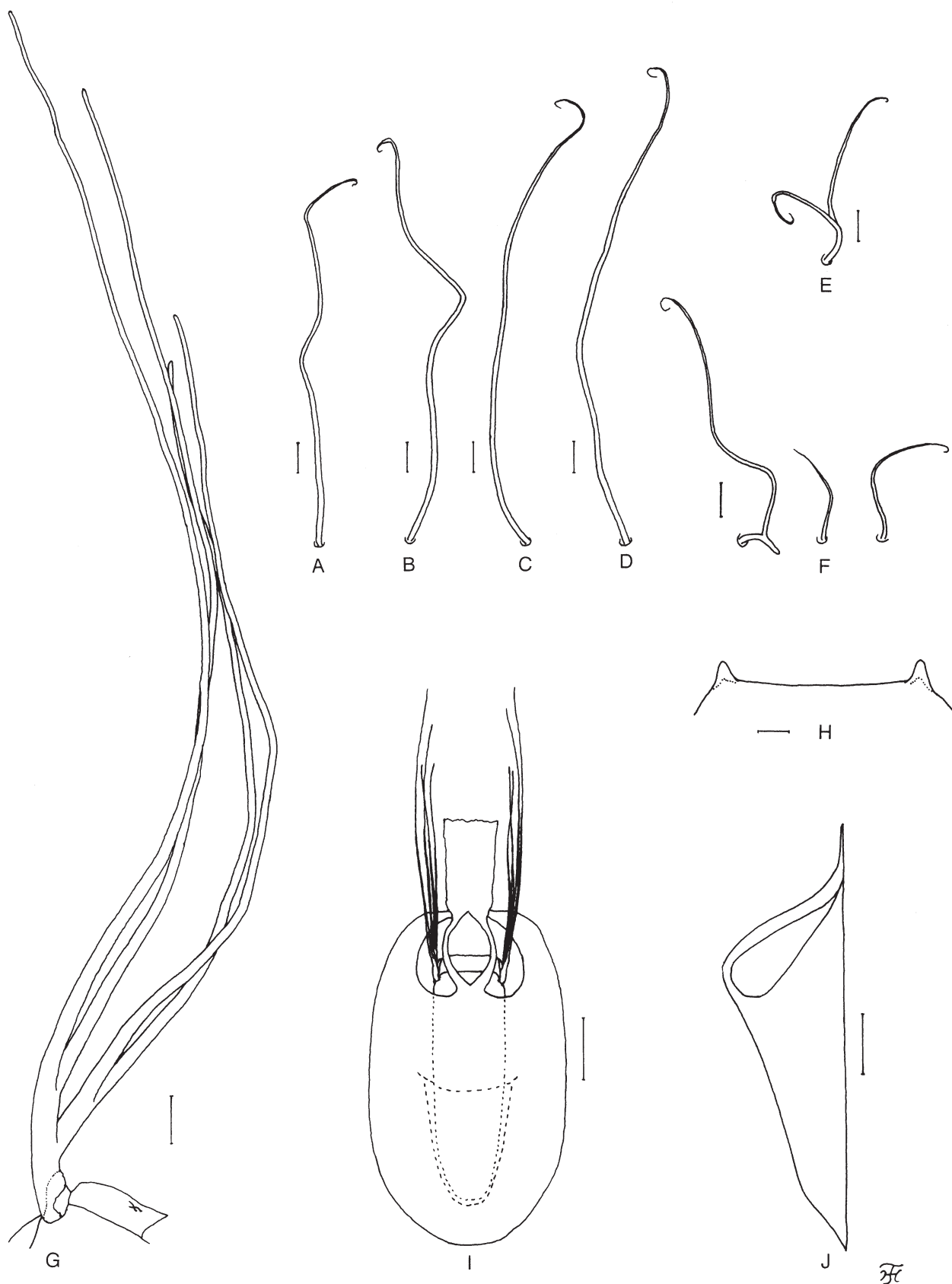
**Remarks.** The male of *S. (G.) sachini* is very similar to that of *S. (G.) nuwakotense* **sp. nov.** in many characteristics including the genitalia and color of legs. The hind basitarsus of this species appears to be somewhat wider than that of *S. (G.) nuwakotense* **sp. nov.** as shown by its relative widths against the hind tibia and femur (i.e., 0.80–0.84 and 0.80–0.83 versus 0.78 and 0.75 in *S. (G.) nuwakotense* **sp. nov.**). The male of *S. (G.) sachini* is readily distinguished from that of *S. (G.) gombakense* by the ventral plate with two ventrally-produced processes (similar to Fig. 12F) as well as the somewhat widened spindle-shaped hind basitarsus (similar to Fig. 12B). The male of *S. (G.) gombakense* bears the ventral plate with a single ventrally-produced median process and the nearly parallel-sided slender hind basitarsus (Takaoka 2000).

#### (IV) Subgenus *Nevermannia* Enderlein

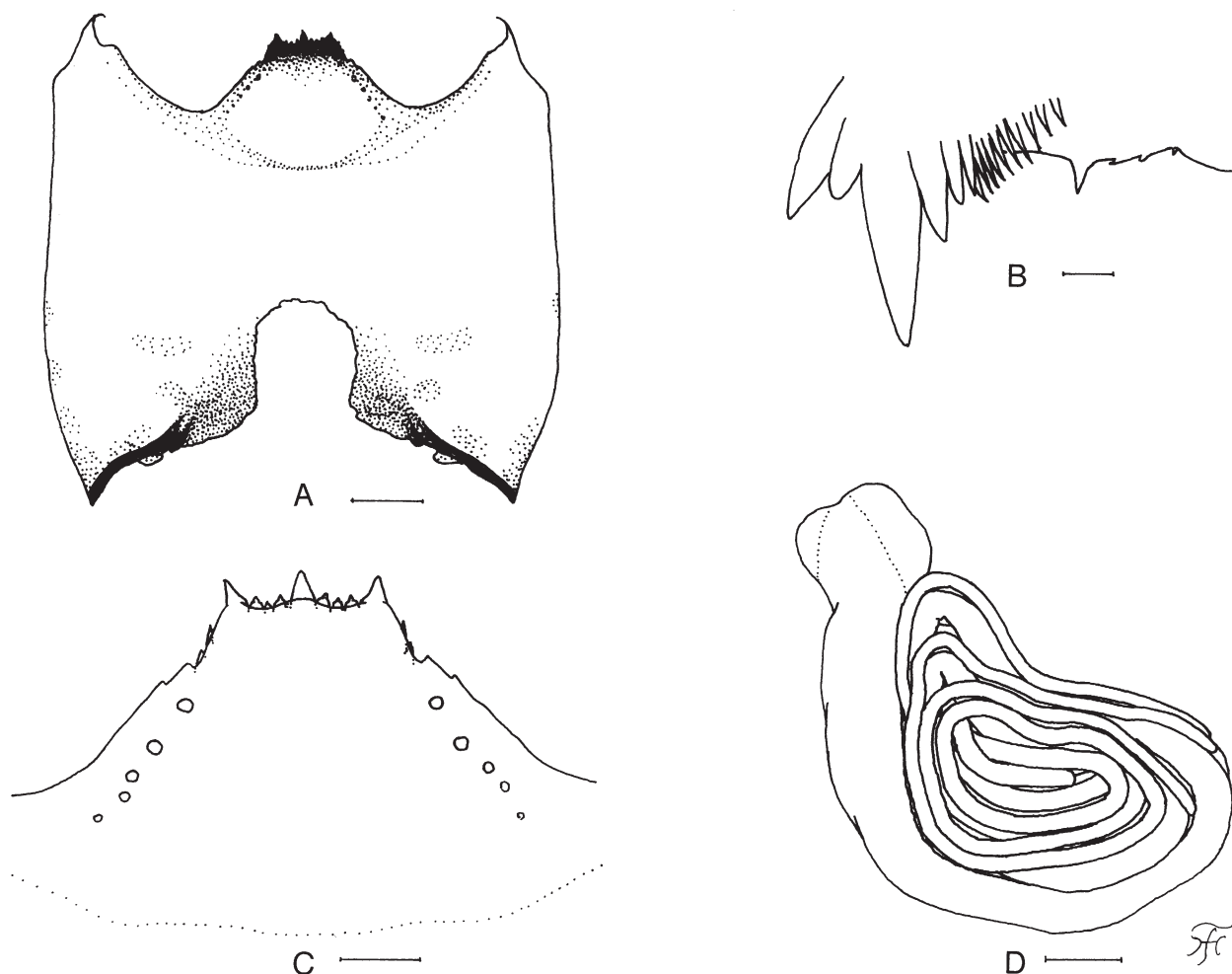
##### (i) *Vernum* species-group

##### *Simulium (Nevermannia) lekhamiense* Takaoka & Shrestha **sp. nov.**

**Description. Pupa.** Body length (excluding gill filaments) 4.2 mm. **Head.** Integument yellow, moderately covered with round tubercles except dorsal 1/2 of frons sparsely covered with tubercles; antennal sheath bare except near base very sparsely covered with small tubercles; frons with 2 simple very long trichomes with coiled apices (Fig. 15A) very close together (another 1 trichome probably lost because 1 socket present) on each side; face with 1 simple very long trichome with coiled apex (Fig. 15B) on each side. **Thorax.** Integument yellow, moderately covered with small tubercles except anterodorsal surface sparsely covered with small tubercles; thorax with 2 simple very long trichomes with coiled apices mediodorsally (Fig. 15C), 1 simple very long trichome with coiled apex (Fig. 15D) (another 1 trichome probably lost) anterolaterally, 1 bifid medium-long trichome with coiled apex mediolaterally (Fig. 15E), and 3 simple trichomes (1 long with coiled apex, 1 medium-long with coiled apex, 1 medium-long with uncoiled apex) ventrolaterally (Fig. 15F). Gill (Fig. 15G) with 4 slender thread-like filaments, slightly longer than pupal body, arranged vertically in dorsal and ventral pairs, each with short stalk arising from short common basal stalk; common basal stalk much thicker than interspiracular trunk, and with transparent swollen portion ventrally; stalks of dorsal and ventral pairs subequal in length to each other and somewhat shorter than common basal stalk; stalk of dorsal pair slightly thicker than stalk of ventral pair; dorsal filament of dorsal pair longest (4.9 mm long), 2 filaments of ventral pair shortest (3.5–3.6 mm long) and ventral filament of dorsal pair intermediate (4.2–4.5 mm long); all filaments medium brown, directed forward, gradually tapered toward apex, with annular furrows at irregular intervals along basal 1/2 and moderately-defined ridges and furrows at regular intervals along apical 1/2, and densely covered with minute tubercles on outer surface. **Abdomen.** Dorsally, segments 1 and 2 moderately sclerotized, yellowish-brown and weakly tuberculate; 1 hair-like seta on each side of segment 1 lost; segment 2 with 5 dark spinous short setae (1 hair-like seta lost) on each side; segments 3 and 4 weakly tuberculate, each with 4 dark stout hooks and 1 dark short spinous seta on each side; segments 5–9 each with spine-combs and comb-like groups of minute spines in transverse rows on each side; segment 9 with pair of cone-shaped terminal hooks (Fig. 15H). Ventrally, segment 4 with 1 dark simple and 1 dark bifid hooklets (slightly shorter and smaller than those on segments 5–7) and few simple short setae on each side; segment 5 with 2 dark bifid hooks and few simple short setae on each side; segments 6 and 7 each with 1 dark bifid inner hook and 1 dark simple outer hook, and few simple short setae on each side; segments 4–8 each with comb-like groups of minute spines. **Cocoon** (Fig. 15I,J). Wall-pocket-shaped, moderately woven, anterior margin thickly woven, and extending ventrolaterally, with 2 long narrow strong anterodorsal projections first divergent, then, convergent and bent downward, then appearing to unite with each other forming broad thin flap extending forward along surface of substrate; cocoon appearing to bear 3 open windows anteriorly when viewed from above; floor woven on posterior 1/2; individual threads visible; 5.5 mm long (excluding anterior flap) by 3.2 mm wide.



**FIGURE 15.** Pupa of *Simulium (Nevermannia) lekhaniense* **sp. nov.** A, frontal trichome; B, facial trichome; C–F, thoracic trichomes (C, mediodorsal; D, anterolateral; E, mediolateral; F, ventrolateral); G, gill filaments (right side; outer view); H, terminal hooks (end view); I, cocoon and pupa (dorsal view); J, cocoon (lateral view). Scale bars. 1.0 mm for I & J; 0.2 mm for G; 0.02 mm for A–F & H.



**FIGURE 16.** Mature larva of *Simulium* (*Nevermannia*) *lekhaniense* **sp. nov.** A, head capsule showing nearly quadrate postgenal cleft (ventral view); B, apical portion of mandible; C, hypostoma; D, histoblast of pharate pupal gill (left side; outer view). Scale bars. 0.1 mm for A & D; 0.04 mm for C; 0.01 mm for B.

**Mature larva.** Body length 6.9 mm. Body color creamy though posterior abdominal segments very faintly grayish dorsally. Cephalic apotome yellowish-white though somewhat darkened narrowly along posterior margin; all head spots medium brown. Lateral surface of head capsule yellow though eye-spot region yellowish-white and area in front of posterior margin somewhat darkened; eyebrow darkened and well-defined; 2 large and 1 or 2 small dark spots near posterior margin, and 1 small dark spot below eye-spot region present. Ventral surface of head capsule (Fig. 16A) yellow, with dark brown area on each side of postgenal cleft; elongate spot on each side of postgenal cleft positive. Cervical sclerites composed of 2 brown rod-like small pieces, not fused to occiput, widely separated from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00: 1.28:0.86. Labral fan with 40 rays. Mandible (Fig. 16B) with 1st comb-tooth longest, followed by 2nd one which is as long as 3rd one; mandibular serrations composed of 2 teeth (1 large and 1 small); large tooth at obtuse angle to mandible on apical side; 2 or 4 supernumerary serrations present. Hypostoma (Fig. 16C) with row of 9 apical teeth, median tooth most prominent, followed by corner teeth, and intermediate teeth smallest; lateral margin with 1 blunt tooth near apex; hypostomal bristles 5 in row, lying nearly parallel to lateral margin on each side. Postgenal cleft (Fig. 16A) of medium-size, as long as postgenal bridge, nearly parallel-sided and rounded anteriorly. Histoblast of pharate pupal gill (Fig. 16D) with 4 slender filaments arranged in 2 pairs with short stalks. Thoracic cuticle bare. Abdominal cuticle almost bare except few posterior segments sparsely or moderately covered with colorless minute setae dorsally and dorsolaterally (even laterally near

ventral papillae) and also on both sides of anal sclerite. Rectal scales appearing to be absent. Rectal organ compound, each lobe with 8–11 finger-like secondary lobules. Anal sclerite X-shaped, with basal juncture broadly sclerotized; anterior arms of medium-long, broad, 0.83 times as long as posterior ones; accessory sclerites absent; sensillum absent. Ventral papillae small and conical. Posterior circle with 78 rows of up to 12 hooks per row.

**Female and male.** Unknown.

**Type specimens.** Holotype pupa with its cocoon (preserved in 80% ethanol), collected from a small water canal (water temperature 21.0°C, exposed to the sun, altitude 1,606 m, 28°24'06.8" N, 83°50'32.4" E) moderately flowing through hilly area, Jhakrithan, Lekhani, Baglung, Nepal, 23.IX.2009. Paratype: 1 mature larva (preserved in 80% ethanol), collected from a very rapidly-flowing stream (width 2m, water temperature 10.0°C, exposed to the sun, altitude 2,532 m, 28°64'32.9" N, 83°66'32.0" E), Lete, Mustang, Nepal, 23.IX.2009.

**Biological notes.** The pupa and larva of this new species were collected from grass leaves trailing in water. Associated species were *S. (N.) letense* **sp. nov.**, *S. (M.) dattai* and *S. (S.)* sp.

**Etymology.** The species name *lekhamiense* refers to the locality name, Lekhani, where this new species was collected

**Remarks.** This new species appears to be assigned to the *vernum* species-group of the subgenus *Simulium* (*Nevermannia*) in having the pupal gill with four long slender filaments (Fig. 15G) and the larval mandible with supernumerary serrations (Fig. 16B). This new species is remarkable in having the cocoon with three open windows anteriorly (Fig. 15I).

### ***Simulium (Nevermannia) letense* Takaoka & Shrestha sp. nov.**

**Description. Female.** Body length 3.4 mm. **Head.** Slightly narrower than width of thorax. Frons dark brown, thinly whitish-gray pruinose, moderately covered with whitish-yellow recumbent short hairs (except mediolongitudinal area bare) interspersed with few dark brown long hairs along lateral margins; frontal ratio 1.40:1.00:1.42. Frons-head ratio 1.00:4.10. Fronto-ocular area (Fig. 17A) directed laterally and slightly upward, rounded apically. Clypeus (Fig. 17B) dark brown, thinly whitish-gray pruinose, slightly shiny at certain angle of light, sparsely covered with yellow short hairs interspersed with several dark brown long hairs though mediolongitudinal area of upper 3/5 widely bare. Labrum 0.93 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, entirely dark brown; 1st flagellomere 2.09 times as long as 2nd one. Maxillary palp composed of 5 segments, medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.87:1.39; 3rd segment (Fig. 17C) somewhat enlarged; sensory vesicle (Fig. 17C) enlarged, ellipsoidal, 0.41 times as long as 3rd segment, and with large opening apically. Maxillary lacinia with 12 inner and 14–16 outer teeth. Mandible with 28 inner and 12 outer teeth. Cibarium (Fig. 17D) with several very minute processes on transparent membrane covering anterior portion. **Thorax.** Scutum dark brown to brownish-black except anterolateral calli medium brown, slightly shiny at certain angle of light, densely covered with whitish-yellow to yellow recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Scutellum dark brown, slightly shiny when illuminated at certain angle of light, covered with whitish-yellow short hairs and dark brown long hairs. Postnotum dark brown, slightly shiny when illuminated at certain angle of light, bare. Pleural membrane bare. Katepisternum dark brown, longer than deep, slightly shiny when illuminated at certain angle of light, and bare. **Legs.** Medium to dark brown. Fore basitarsus somewhat dilated, 7.48 times as long as its greatest width. Hind basitarsus (Fig. 17E) slender, nearly parallel-sided, 7.35 times as long as wide, and 0.72 and 0.68 times as wide as tibia and femur, respectively; calcipala (Fig. 17E) well developed, short, 0.79 times as long as basal width, and 0.49 times as wide as greatest width of basitarsus; pedisulcus (Fig. 17E) well developed; claw (Fig. 17F) with small subbasal tooth. **Wing.** Length 3.0 mm. Costa with dark brown spinules and hairs except basal patch of hairs yellowish-white. Subcosta with dark brown hairs except apical 1/3 bare. Hair tuft on stem vein dark brown.

Basal portion of radial vein fully haired.  $R_1$  with dark brown spinules and hairs.  $R_2$  with dark brown hairs only. Basal cell and basal median cell absent. **Abdomen.** Basal scale medium to dark brown, with fringe of yellowish-white long hairs; dorsal surface of abdominal segments medium brown except base of segment 2 yellowish-white, rest of segment 2 and posterior 1/3 of segment 3 light brown, and all tergites medium brown, and moderately covered with whitish-yellow short hairs as well as dark brown short to medium-long hairs; tergites 7–9 shiny when illuminated at certain angle of light; ventral surface of segments 2–5 light ochreous, segments 6 and 7 light brown and segment 8 medium brown; segment 7 with weakly defined large sternal plate medially. **Genitalia.** Sternite 8 (Fig. 17G) bare medially, and with 15–17 short to long hairs on each side. Ovipositor valves (Fig. 17G) roughly triangular, rounded medioposteriorly, thin, membranous, densely covered with microsetae interspersed with 5–9 fine short setae (though 1 seta on right side medium-long); inner margin moderately sclerotized and narrowly darkened. Genital fork (Fig. 17H) of usual inverted-Y form, stem slender and well sclerotized; arms widened, each with angulated strongly-sclerotized apical ridge directed anterodorsally or laterodorsally. Paraproct in ventral view (Fig. 17I) subquadrate, with strongly-sclerotized anterior surface, covered with 11–13 medium-long and long hairs on ventral and lateral surface, with 7 or 8 sensilla on anteromedial transparent surface; paraproct in lateral view (Fig. 17J) slightly produced ventrally beyond ventral margin of cercus. Cercus in ventral view (Fig. 17I) narrow, with widely concave inner surface; cercus in lateral view (Fig. 17J) rounded, 0.68 times as long as wide, and with several dark medium-long to long hairs. Spermatheca (Fig. 17K) small, ovoidal, 1.22 times as long as its greatest width, well sclerotized except area at juncture with duct, with reticulate surface pattern; internal setae absent; main duct and both accessory ducts subequal in diameter to one another.

**Male.** Unknown.

**Pupa.** Body length (excluding gill filaments) 3.0–3.2 mm. **Head.** Integument (Fig. 18A) dark yellow, moderately covered with relatively large tubercles bearing minute secondary projections (Fig. 18B) on frons, sparsely covered with small tubercles on each lateral surface of face and almost bare on down surface of face; antennal sheath in lateral view (Fig. 18C) with undulate outer margin, sparsely or moderately covered with small tubercles, some of which bear minute secondary projections; frons with 2 simple slender trichomes of variable lengths with uncoiled apices on each side (e.g., 2 long on left side (Fig. 18A), 1 long and 1 short on right side in 1 pupa; 2 short on left side, 2 medium-long on right side in another pupa); face with 1 simple long trichome with uncoiled apex (Fig. 18A) on each side. **Thorax.** Integument (Fig. 18D,E) light yellowish-brown, with 5 distinct elongate carinae on dorsal surface of anterior 1/2 (i.e., 1 medial carina running from anterior margin backward to middle and turning outward for very short distance, 2 submedial carinae running inward along anterior margin from base of gill, and turning backward to middle, 2 lateral carinae running backward from base of gill along dorsolateral margin to middle and turning inward for short distance, posterior tips of these carinae approaching close together but not contiguous to one another at same height, and pair of round submedial ridges on dorsal surface of posterior 1/3, which are located close together but not contiguous to each other at same height; thoracic integument covered with relatively large tubercles bearing minute secondary projections (similar to those on frons) densely on carinae and ridges, moderately on intercarinae areas (Fig. 18F), and covered with relatively smaller tubercles on dorsal surface of posterior 1/4 (or 1/3) and on each lateral surface; thorax on each side with 4 simple short slender trichomes with uncoiled apices (1 on submedial carina, 3 on area between submedial and lateral carinae) dorsally (Fig. 18D), 1 simple medium-long trichome with uncoiled apex mediolaterally (Fig. 18D,E), and 3 simple trichomes with uncoiled apices (1 long, 1 medium-long, 1 short) ventrolaterally (Fig. 18E), and 2 simple trichomes with uncoiled apices (1 medium-long, 1 short) anterolaterally below base of gill (Fig. 18E). Gill (Fig. 18G) with 4 slender thread-like short filaments, much shorter than pupal body, arising at same level from short common basal stalk, which is directed outward and black; common basal stalk little thicker than interspiracular trunk, and with transparent swollen portion ventrally at base; all filaments subequal in length (1.4–1.6 mm long) and thickness to one another, medium brown, very slightly tapered toward apex, furnished with annular ridges and furrows at very short regular intervals, and densely covered with minute tubercles on outer surface. **Abdomen.** Dorsally, segment 1, anterior 1/2 of segments 2–4 very weakly sclerotized and light brown; segments 1 and 2



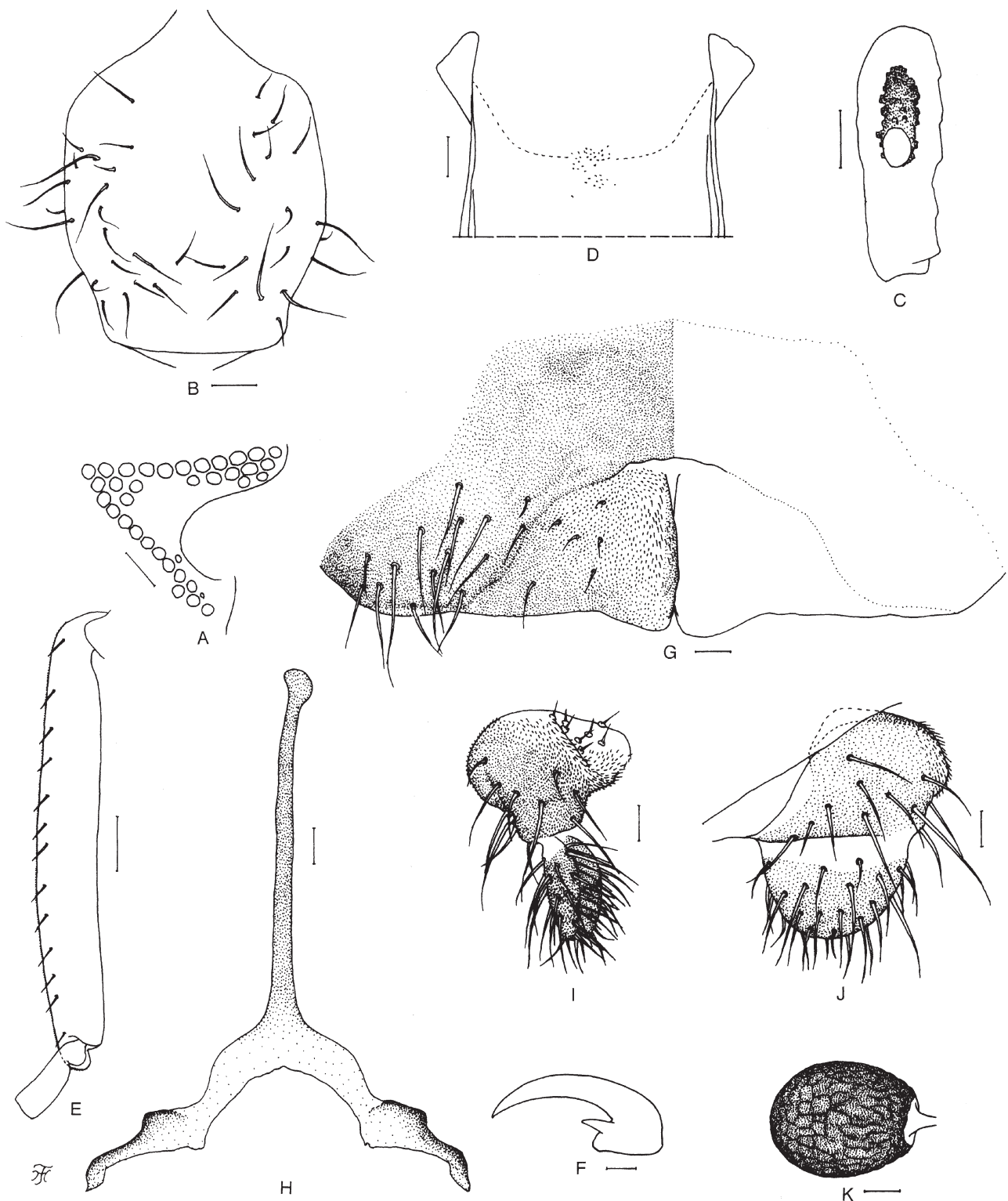
sparsely tuberculate; segment 1 with 1 simple slender short seta on each side; segment 2 with 1 simple slender short seta and 5 dark spinous very short setae on each side; segments 3 and 4 each with 4 dark stout hooks (though 3 hooks on each side on segment 3 in 1 pupa) and 1 dark very short spinous seta on each side; segments 5–9 without spine-combs in 1 pupa, or segments 7 and 8 each with spine-combs lying transversely along anterior margin on each side (though 1 and 2 spines on segment 7, and 4 and 6 spines on segment 8) in 1 pupa; segments 5–9 each with comb-like groups of minute spines in transverse rows on each side; segment 9 with pair of cone-shaped terminal hooks (Fig. 18H). Ventrally, segment 4 with 1 dark simple hooklet (slightly shorter and smaller than those on segments 5–7) and 3 simple short setae (1 dark, 2 yellow) on each side; segment 5 with 2 dark bifid hooks and few simple short setae on each side; segments 6 and 7 each with 1 dark bifid inner hook and 1 dark simple or bifid outer hook, and few simple short setae on each side; segments 4–8 each with comb-like groups of minute spines. **Cocoon** (Fig. 18I). Flat, round, with thickly woven round anterior opening in dorsal view; cocoon moderately woven, individual threads visible or not; floor woven on posterior 1/2; 4.0–4.6 mm long by 3.2–3.4 mm wide. Cocoon covering only abdomen and posterior tip of thorax of pupa.

**Mature larva.** Body length 6.0–6.2 mm. Body color creamy though posterior abdominal segments very faintly grayish dorsally in 1 larva, or body color almost entirely grayish in 1 larva. Cephalic apotome yellow to light brown; head spots positive though posteromedial and posterolateral spots blurred. Lateral surface of head capsule yellow to light brown except eye-spot region whitish and area in front of posterior margin somewhat darkened; eyebrow darkened and well-defined, with 1 dark spot; 2 large and 1 or 2 small dark spots near posterior margin, and 1 small dark spot below eye-spot region present. Ventral surface of head capsule (Fig. 19A) light brown though near posterior margin of hypostoma yellow, with dark brown area on each side of postgenal cleft; elongate spot on each side of postgenal cleft positive. Cervical sclerites composed of 2 brown rod-like small pieces, not fused to occiput, widely separated from each other. Antenna composed of 3 segments and apical sensillum, much longer than stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.00:1.23–1.49:0.53–0.63. Labral fan with 38 rays. Mandible (Fig. 19B,C) with 1st comb-tooth longest, followed by 2nd one which is as long as or slightly longer or shorter than 3rd one; mandibular serrations composed of 2 teeth (1 large and 1 small); large tooth at obtuse angle to mandible on apical side; 1–3 supernumerary serrations present. Hypostoma (Fig. 19D) with row of 9 apical teeth, median tooth most prominent, followed by corner teeth, and intermediate teeth smallest; lateral margins smooth except near apex serrated; hypostomal bristles 6 or 7 in row, lying parallel to or slightly divergent from lateral margin on each side. Postgenal cleft (Fig. 19A,E) of medium-size, 1.1 times as long as postgenal bridge, somewhat pointed or rounded anteriorly. Histoblast of pharate pupal gill (Fig. 19F) with 4 slender filaments; basal common stalk blackish inside. Thoracic and abdominal cuticle almost bare except last abdominal segment moderately covered with colorless minute setae on both sides of anal sclerite. Rectal scales darkened, easily discernible. Rectal organ compound, each lobe with 18–24 finger-like secondary lobules. Anal sclerite X-shaped, with basal juncture area broadly sclerotized; anterior arms short, broad, 0.65 times as long as posterior ones; accessory sclerites absent; sensillum absent. Ventral papillae small and conical. Posterior circlet with 85 rows of up to 12 hooks per row.

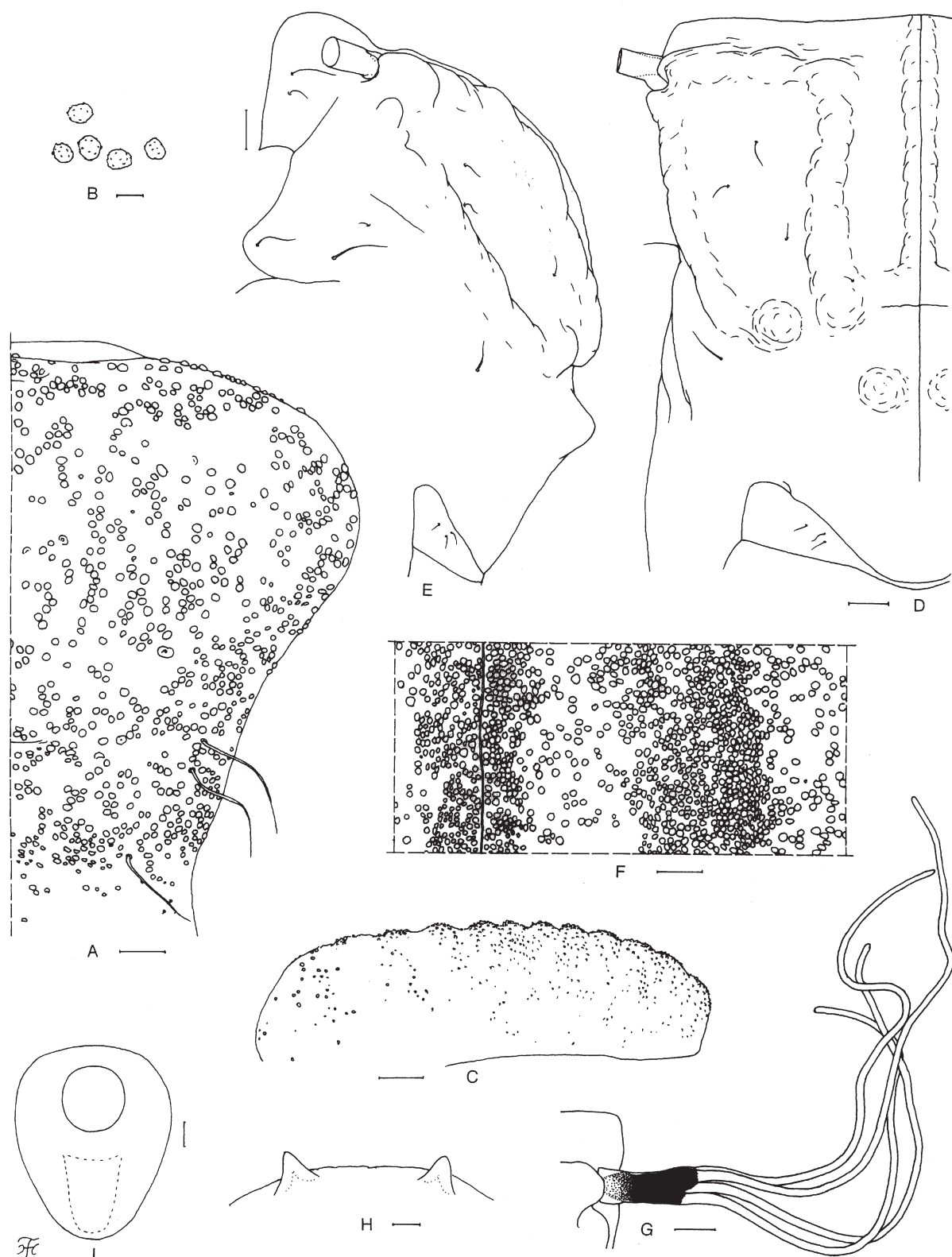
**Type specimens.** Holotype female (with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), collected from a very rapidly-flowing stream (width 2m, water temperature 10.0°C, exposed to the sun, altitude 2,532 m, 28°64'32.9" N, 83°66'32.0" E), Lete, Mustang, Nepal, 23.IX.2009. Paratypes: 2 mature larvae, same date and data as those of the holotype; 3 pupae collected from a small water canal (water temperature 21.0°C, exposed to the sun, altitude 1,606 m, 28°24'06.8" N, 83°50'32.4" E) moderately flowing through hilly area, Jhakrithan, Lekhani, Baglung, Nepal, 23.IX.2009.

**Biological notes.** The pupae and larvae of this new species were collected from grass leaves trailing in water. Associated species are *S. (N.) lekhamiense* sp. nov., *S. (M.) dattai* and *S. (S.)* sp.

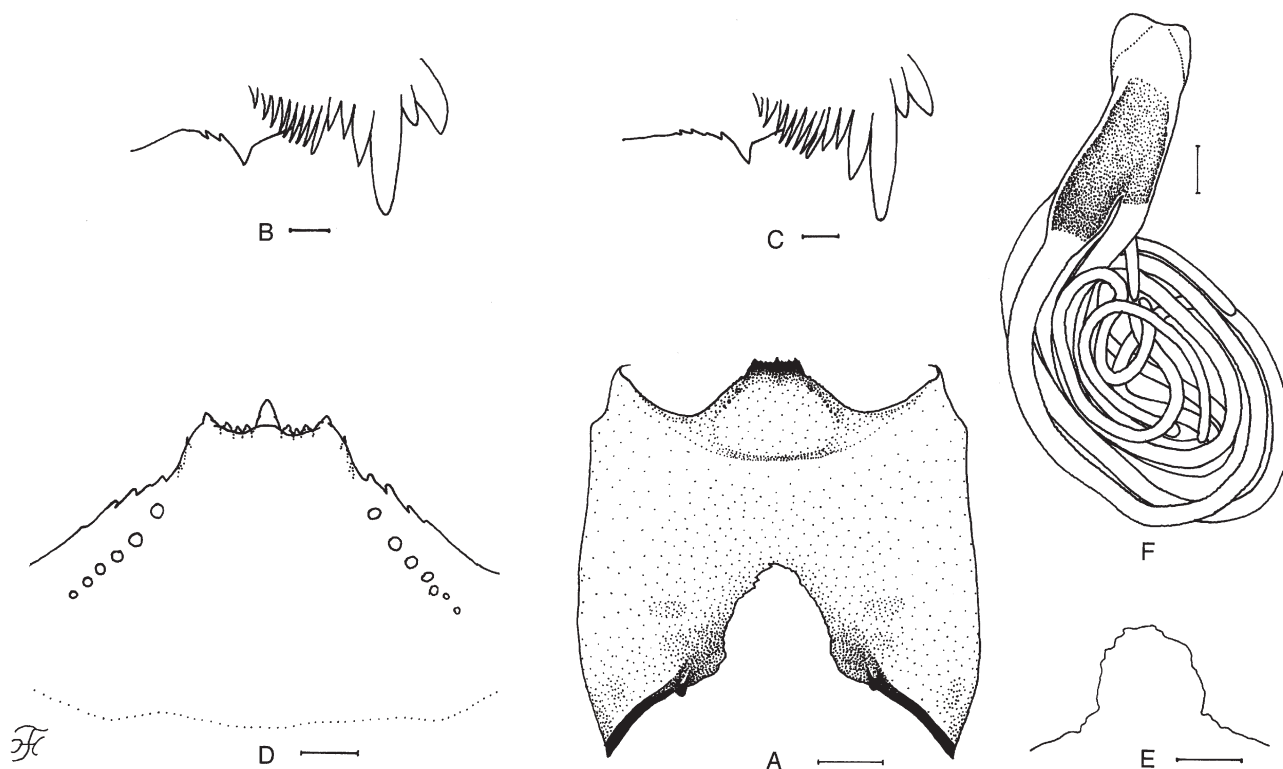
**Etymology.** The species name *leteense* refers to the locality name, Lete, where this new species was collected.



**FIGURE 17.** Female of *Simulium* (*Nevermannia*) *letense* **sp. nov.** A, fronto-ocular area (right side; front view); B, clypeus (front view); C, 3rd segment of maxillary palp with sensory vesicle (right side; front view); D, upper part of cibarium; E, basitarsus and 2nd tarsomere of hind leg (left side; outer view); F, claw with small basal tooth (lateral view); G, 8th sternite and ovipositor valves (ventral view); H, genital fork (ventral view); I & J, paraproct and cercus (right side; I, ventral view; J, lateral view); K, spermatheca (lateral view). Scale bars. 0.1 mm for E; 0.04 mm for A–C; 0.02 mm for D and G–K; 0.01 mm for F.



**FIGURE 18.** Pupa of *Simulium* (*Nevermannia*) *letense* **sp. nov.** A, frons and upper part of face showing 3 trichomes (2 frontal and 1 facial) and large tubercles on most of frons (left half); B, large tubercles with several tiny secondary projections on frons; C, antennal sheath covered with small tubercles (left side; outer view); D & E, thorax showing raised carinae (D, dorsal view; E, outer view); F, part of dorsal surface of thorax showing median and submedian carinae densely covered with large tubercles and intercarinae areas moderately or sparsely covered with large tubercles; G, gill composed of 4 short slender filaments arising from common basal stalk which appears nearly black (dorsal view); H, terminal hooks (end view); I, cocoon with anterior collar (dorsal view). Scale bars. 0.5 mm for I; 0.1 mm for D, E & G; 0.05 mm for A, C & F; 0.01 mm for B & H.



**FIGURE 19.** Mature larva of *Simulium* (*Nevermannia*) *letense* **sp. nov.** A, head capsule showing triangular postgenal cleft (ventral view); B & C, apical portions of mandible showing difference of relative length of comb-teeth and of number of supernumerary serrations between 2 larvae; D, hypostoma; E, postgenal cleft with round anterior margin; F, histoblast of pharate pupal gill showing blackish common basal stalk (left side; outer view). Scale bars. 0.1 mm for A & E; 0.05 mm for F; 0.03 mm for D; 0.01 mm for B & C.

**Remarks.** *Simulium* (*N.*) *letense* **sp. nov.** is assigned to the *vernum* species-group within the subgenus *Nevermannia* redefined by Takaoka (2003) in that it has the genital fork with no distinct projection (Fig. 17H), and the paraproct which is longer than the cercus (Fig. 17J) in the female, the gill with four filaments (Fig. 18G) in the pupa and the mandible with supernumerary serrations (Fig. 19B,C) in the larva.

This new species appears to be closely related to *S.* (*N.*) *planipuparium* Rubtsov originally described from Tadzhikistan (Rubtsov 1989) in sharing the pupal thorax with distinct carinae on the dorsal surface (Fig. 18D,E) coupled with the pupal gill with four short slender filaments (Fig. 18G) and the round flat cocoon with an anteroventral collar (Fig. 18I). However, this new species is distinguished from the latter known species in the female by the claw with a small subbasal tooth (Fig. 17F) (in place of a large tooth) and in the pupa by the presence of a medial carina and a pair of round ridges in addition to the submedian and lateral carinae (Fig. 18D,E), and the pupal gill with the black common basal stalk (Fig. 18G) (not all portions of the gill filaments black).

## (V) Subgenus *Simulium* Latreille s. str.

### (i) *Griseifrons* species-group

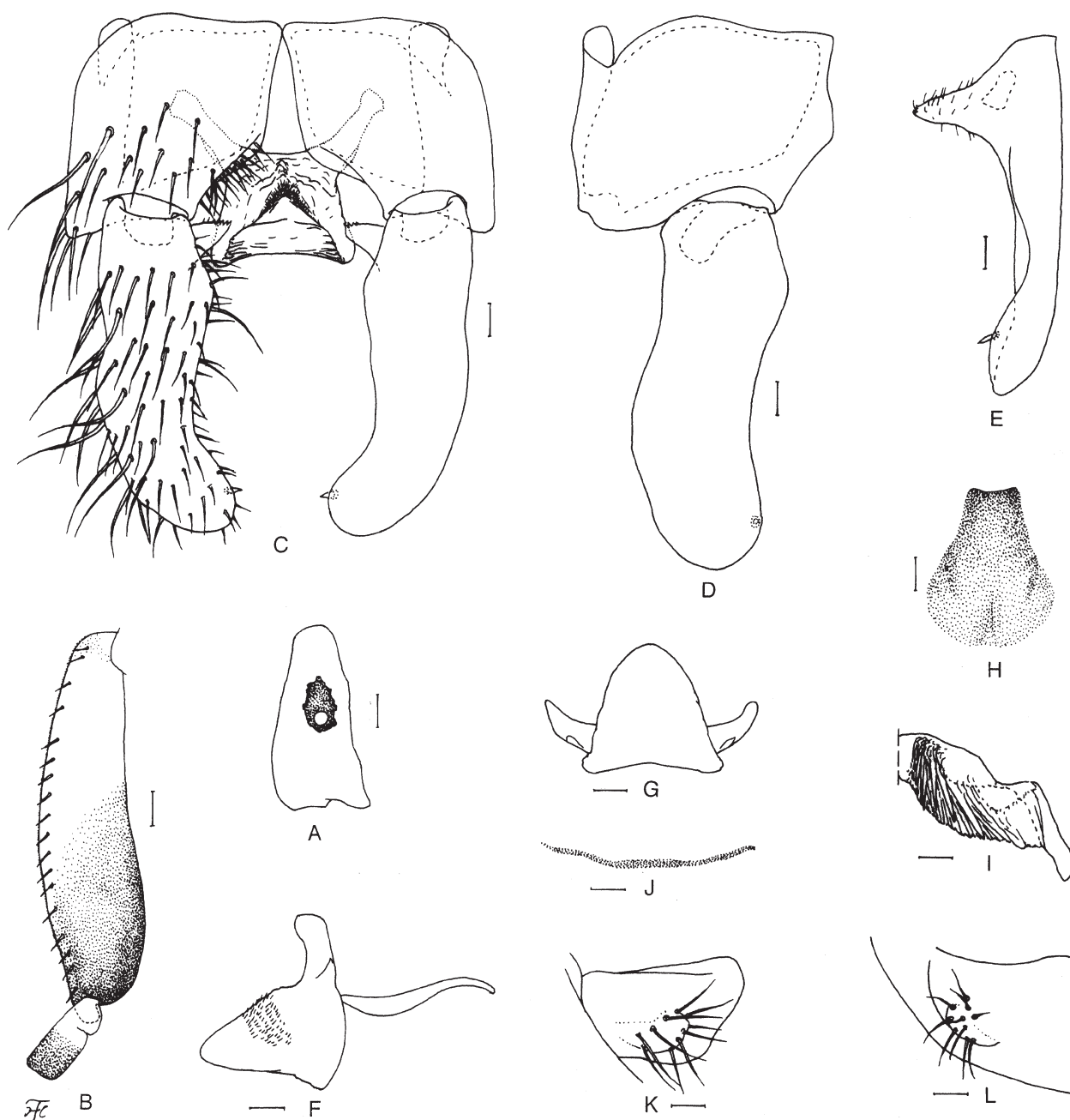
#### *Simulium* (*Simulium*) *titarensis* Takaoka & Shrestha **sp. nov.**

**Description. Male.** Body length 3.0 mm. **Head.** Wider than thorax. Upper eye consisting of large facets in 20 vertical columns and in 20 horizontal rows. Clypeus brownish-black, thickly white pruinose and brightly iri-



descent when illuminated at certain angle of light, sparsely covered with dark brown hairs along and near lateral margins (most of central portion bare). Antenna composed of scape, pedicel and 9 flagellomeres, medium to dark brown except scape and pedicel dark yellow and base of 1st flagellomere yellow when viewed dorsally (though 1st to 3rd flagellomeres appearing dark yellow to light brown when viewed ventrally); 1st flagellomere elongate, 1.82 times as long as 2nd one. Maxillary palp dark brown, composed of 5 segments with proportional lengths of 3rd, 4th, and 5th segments 1.00:1.29:2.78; 3rd segment (Fig. 20A) of normal size; sensory vesicle (Fig. 20A) ellipsoidal, 0.31 times as long as 3rd segment, and with small opening. **Thorax.** Scutum brownish-black to black, with whitish-gray pruinose pattern, i.e., anterior pair of large spots on shoulders extending posteriorly along lateral margins and connected to large transverse spot entirely covering prescutellar area; either anterior or posterior 1/2 of large pruinose spot on each shoulder disappearing depending on angle of light; pruinose areas brightly iridescent when illuminated at certain angle of light; scutum uniformly and moderately covered with yellow recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Scutellum dark brown, with several dark long upright hairs as well as yellow short recumbent hairs. Postnotum dark brown, bare. Pleural membrane bare. Katepisternum brownish-black, bare. **Legs.** Foreleg: coxa yellow; trochanter yellow except ventral surface light brown; femur yellow except apical cap medium brown; tibia yellowish-white except apical cap and inner margin dark brown, and with white large sheen on outer surface; tarsus dark brown, with moderate dorsal hair crest; basitarsus greatly dilated, 5.33 times as long as its greatest width. Midleg: coxa brownish-black; trochanter dark brown except base whitish-yellow; femur yellow except apical cap dark yellow; tibia yellowish-white to yellow except apical cap medium brown; tibia with white large sheen on posterior surface; tarsus medium brown except basal 1/2 of basitarsus yellow. Hind leg: coxa dark brown to brownish-black; trochanter yellow; femur yellow except apical cap medium brown; tibia medium to dark brown except base yellowish-white; tarsus medium brown except little less than basal 1/2 of both basitarsus and 2nd tarsomere yellowish-white (Fig. 20B); basitarsus (Fig. 20B) enlarged, gradually widened from base toward apical 1/4, then narrowed to apex, 3.75 times as long as wide, and 0.96 and 1.14 times as wide as greatest width of hind tibia and femur, respectively; calcipala (Fig. 20B) developed, small, 0.82 times as long as its basal width, and 0.22 times as wide as greatest width of basitarsus; pedisulcus (Fig. 20B) well developed at basal 1/3 of 2nd tarsomere. **Wing.** Length 2.2 mm. Costa with dark brown spinules and hairs. Subcosta with 1 or 2 hairs. Hair tuft on stem vein dark. Basal portion of radius fully haired.  $R_1$  with dark spinules and hairs.  $R_2$  with dark hairs only. Basal cell and basal median cell absent. **Abdomen.** Basal scale brownish-black, with fringe of dark brown long hairs. Dorsal surface of abdomen medium to dark brown, moderately covered with brassy short hairs intermixed with dark brown short to medium-long hairs; segments 2 and 5–7 each with pair of bright iridescent pruinose spots dorsolaterally, those on segment 2 connected broadly to each other in middle; segment 8 also with pair of shiny spots laterally when illuminated at certain angle of light. **Genitalia.** Coxite in ventral view (Fig. 20C) nearly quadrate, 1.16 times as long as wide; coxite in ventrolateral view (Fig. 20D) 0.86 times as long as wide. Style in ventral view (Fig. 20C) and in ventrolateral view (Fig. 20D) elongate, slightly sinuous, nearly parallel-sided, 1.48 times as long as coxite, with subapical spine; style in medial view (Fig. 20E) with long basal protuberance directed dorsomedially, bearing 3 or 4 spinules on its apex. Ventral plate in ventral view (Fig. 20C) with nearly quadrate body, though lateral margins slightly widened posteriorly and posterior margin somewhat concave, and moderately covered with minute setae on anterior and anterolateral surfaces; arms diverged basally from each other at obtuse angle; ventral plate in lateral view (Fig. 20F) triangular, though ventral tip rounded, with no serrated posterior margin; ventral plate in end view (Fig. 20G) bell-shaped, without seta. Median sclerite (Fig. 20H) well sclerotized, plate-like, gradually widened, and with round apical tip. Paramere (Fig. 20I) wide basally, with several short to long hooks. Aedeagal membrane very densely covered with minute setae; dorsal plate (Fig. 20J) small, moderately sclerotized. Abdominal segment 10 (Fig. 20K,L) without distinct hair on ventral surface. Cercus (Fig. 20K,L) small, rounded, with 10 distinct hairs.





**FIGURE 20.** Male of *Simulium (Simulium) titarensis* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (right side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D, coxite and style (right side; ventrolateral view); E, style with basal protuberance (left side; medial view); F, ventral plate and median sclerite (lateral view); G, ventral plate (end view); H, median sclerite (end view); I, paramere with several hooks (left side; end view); J, dorsal plate (ventral plate); K & L, 10th abdominal segment with cercus (right side; K, lateral view; L, end view). Scale bars. 0.05 mm for B; 0.02 mm for A & C–L.

**Pupa.** Body length 3.2 mm. **Head.** Integument yellow to dark yellow, densely and elaborately covered with small round tubercles except antennal sheaths mostly bare; frons with 2 pairs of simple short trichomes (Fig. 21A); face with pair of simple medium-long trichomes (Fig. 21B). **Thorax.** Integument yellow to dark yellow, densely and elaborately covered with small round tubercles except most tubercles on dorsal surface of posterior area covered with cone-shaped tubercles; thorax on each side with 3 trifid or quadrifid long stout trichomes anterodorsally (Fig. 21C), 2 trichomes (1 simple, medium-long, 1 bifid, very long and stout) anterolaterally (Fig. 21D), 1 simple medium-long stout trichome mediolaterally (Fig. 21E), and 3 simple trichomes (2 long, stout, 1 short, slender) ventrolaterally (Fig. 21F). Gill (Fig. 21G) with 6 thread-like

filaments arranged as 2+1+1+1+1 from dorsal to ventral; dorsal pair with short stalk, 4 filaments of ventral and middle groups independently arising (i.e., bases of these filaments not touching each other); lowermost filament shortest (0.95 mm long) and uppermost filament probably longest (tip of this filament on each side lost, then exact length unmeasurable, probably 1.3 mm) and other filaments intermediate in length (1.0–1.2 mm); relative thickness of filaments from dorsal to ventral 1.00:0.82:0.91:0.82:1.00:0.73 (right gill) and 1.00:0.82:0.82:0.82:1.00:0.82 (left gill) when compared basally (inner filament of middle group of left gill and ventralmost filament of right gill very slightly constricted at base); all filaments light ochreous, covered with annular ridges and furrows except basal short portion without such ridges and furrows and densely covered with minute tubercles on entire surface. **Abdomen.** Dorsally, nearly transparent except segment 1 weakly sclerotized and light ochreous; segment 1 without tubercles, with 1 simple short seta on each side; segment 2 without tubercles, with 1 simple short seta and 5 simple very short setae, of which 3 somewhat stout and spinous, on each side; segments 3 and 4 each with 4 distinct simple hooks and 1 simple very short seta on each side; segments 5–7 and 9 lacking spine-combs; segment 8 with distinct spine-combs in transverse row; segments 6–9 each with comb-like groups of minute spines on each side; segment 9 without pair of terminal hooks. Ventrally, segments 3–8 transparent, each with comb-like groups of minute spines; segment 4 with few simple very short setae on each side; segment 5 with pair of bifid stout hooks submedially and few simple very short setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer stout hooks somewhat separated from each other and few simple very short setae on each side. Grapnel-shaped hooklets absent on each side of segment 9. **Cocoon** (Fig. 21H). Light yellow, wall-pocket shaped, with anterolateral windows (1 large open space on right side and 2 medium-sized open spaces on left side), tightly woven and not extending ventrolaterally; individual threads invisible; 3.3 mm long by 1.4 mm wide.

**Female and mature larva.** Unknown.

**Type specimen.** Holotype male (with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), collected from a stream (width 2 m, water temperature 18.0°C, exposed to the sun, altitude 1,700 m, 28°56'37.3" N, 83°63'59.1" E), moderately flowing along the road, on the way to Titar, Mustang, Nepal, 23.IX.2009.

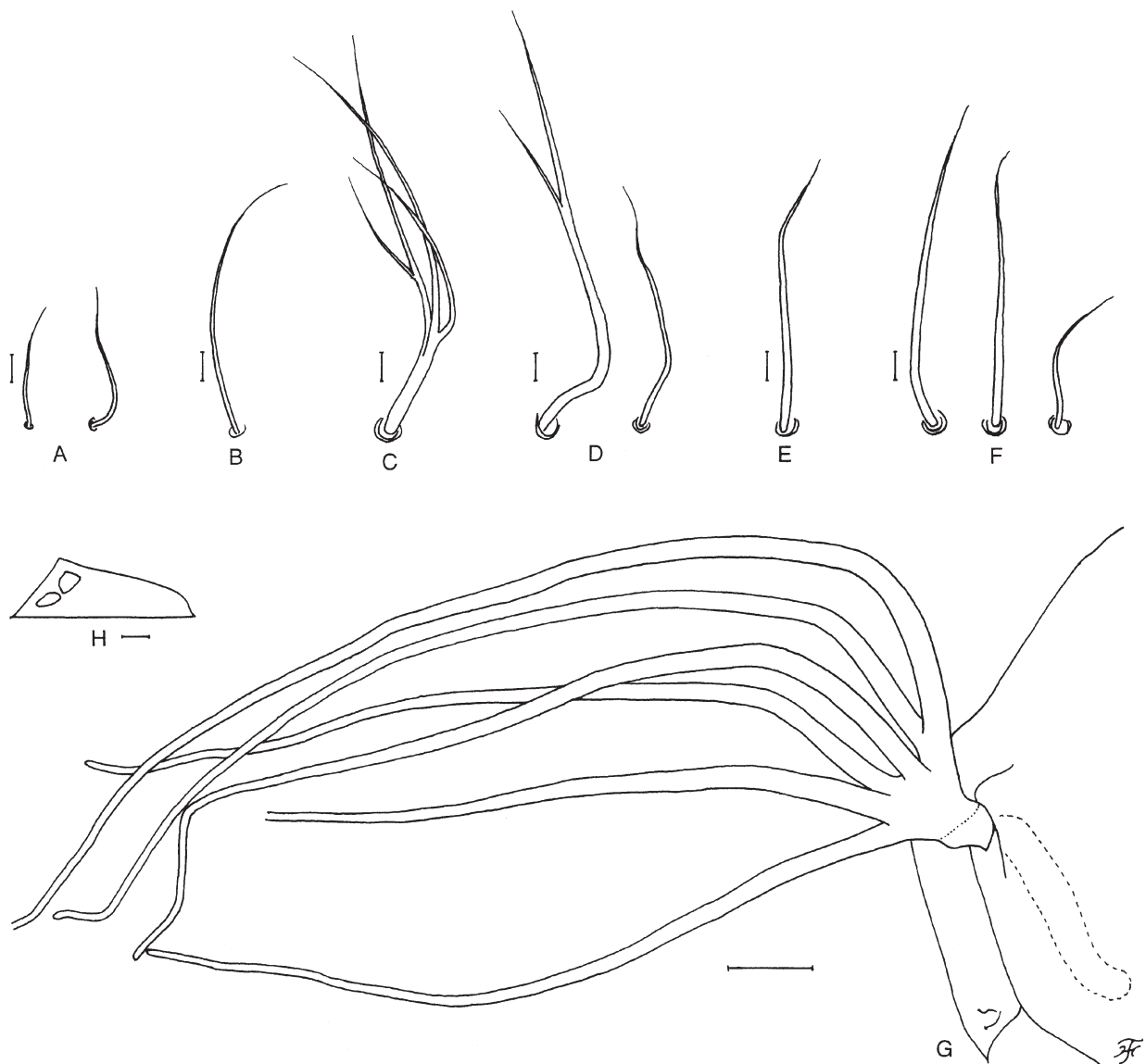
**Biological notes.** The pupa of this new species was collected from a grass leaf trailing in water. No other species was collected.

**Etymology.** The species name *titarensis* refers to the locality name, Titar, where this new species was collected.

**Remarks.** This new species is assigned to the *griseifrons* species-group of the subgenus *Simulium* (*Simulium*) in that it has the style bearing an elongate basal protuberance (Fig. 20E), the ventral plate without toothed posterolateral margins (Fig. 20F,G) in the male, combined with the gill with six filaments (Fig. 21G) in the pupa.

This new species is similar to *S. (S.) hongpingense* Chen, Luo & Yang, *S. (S.) multifurcatum* Zhang & Wang, *S. (S.) ramulosum* Chen, *S. (S.) shangchuanense* An, Hao & Yan, and *S. (S.) shennongjianense* Yang, Luo & Chen, all from China (An *et al.* 1998; Chen 2000; Chen *et al.* 2006; Yang *et al.* 2005; Zhang & Wang 1991) in sharing the following pupal characteristics: head and thoracic integument densely covered with tubercles, thoracic integument with branched trichomes, abdominal segment 9 lacking terminal hooks and cocoon with a large anterolateral window on each side. However, *S. (S.) titarensis* **sp. nov.** is distinguished in the male from *S. (S.) hongpingense*, *S. (S.) shangchuanense* and *S. (S.) shennongjianense* by the shape of the ventral plate which is flat in all these three known species, and also in the pupa from *S. (S.) hongpingense*, *S. (S.) ramulosum* and *S. (S.) shennongjianense* by the absence of spine-combs on the seventh abdominal segment and from *S. (S.) multifurcatum* by the middle and ventral paired filaments which are almost sessile in this new species (Fig. 21G) but short-stalked in *S. (S.) multifurcatum*.

*Simulium (S.) biferaminiferum* Datta described from India (Datta 1974) shows some similarities to this new species in having the six pupal gill filaments and the cocoon with an anterolateral window on each side, but differs by the presence of terminal hooks in the last abdominal segment as well as the presence of spine-combs on the abdominal segments 7–9.



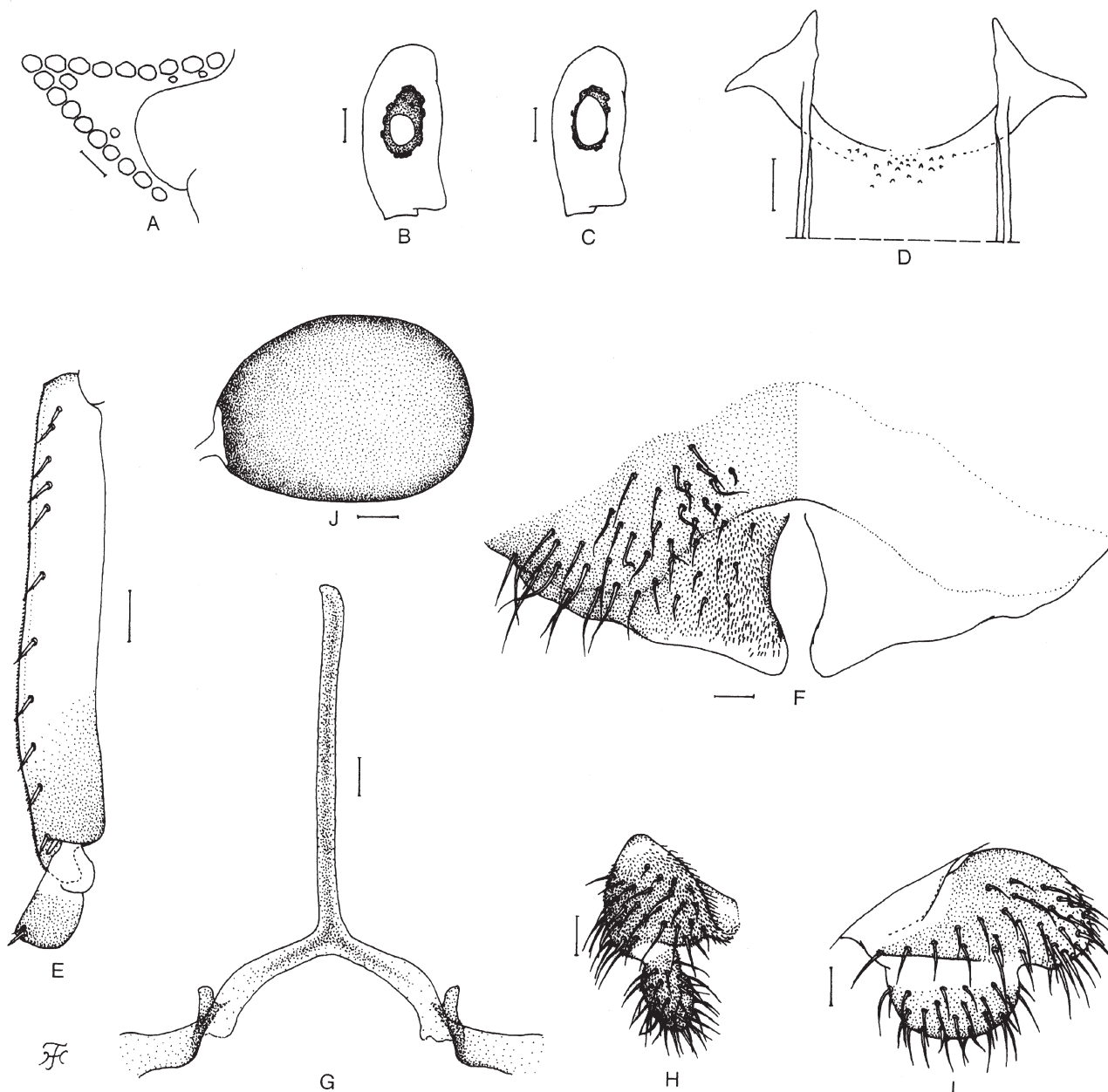
**FIGURE 21.** Pupa of *Simulium (Simulium) titarensis* **sp. nov.** A, frontal trichomes; B, facial trichome; C–F, thoracic trichomes (C, mediodorsal; D, anterolateral; E, mediolateral; F, ventrolateral); G, anterior part of thorax with 6 gill filaments (left side; outer view); H, cocoon (lateral view). Scale bars. 0.5 mm for H; 0.1 mm for G; 0.01 mm for A–F.

## (ii) *Multistriatum* species-group

### *Simulium (Simulium) tamorensis* Takaoka & Shrestha **sp. nov.**

**Description. Female.** Body length 2.3–2.5 mm. **Head.** Slightly narrower than thorax. Frons dark brown, shiny, with several dark stout hairs along lateral margins; frontal ratio 1.15–1.36:1.00:1.18–1.26; frons-head ratio 1.00:3.77–4.59. Fronto-ocular area (Fig. 22A) well developed, short, directed laterally, and round or pointed apically. Clypeus dark brown, thinly white pruinose, shiny, moderately covered with dark stout hairs as well as yellow hairs (though upper 1/2 widely bare medially). Labrum 0.72–0.77 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, yellow on scape, pedicel, and 1st to 3rd flagellomeres, and light to dark brown on rest of flagellomeres in front view; antenna light to dark brown except scape, pedicel, and 1st flagellomere yellow in posterior view. Maxillary palp with 5 segments, light brown except 3rd segment medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.00:0.94–

0.95:2.00–2.09; 3rd segment (Fig. 22B) of normal size, with large oblong sensory vesicle (0.37–0.43 times as long as 3rd segment) having large opening (very large opening in right sensory vesicle in 1 female—Fig. 22C). Maxillary lacinia with 11 or 12 inner and 15 or 16 outer teeth. Mandible with 29–33 inner and 10 or 11 outer teeth. Cibarium (Fig. 22D) with 10–22 minute processes near posterodorsal margin. **Thorax.** Scutum dark brown to brownish-black except anterolateral calli light to medium brown, shiny, densely covered with yellow recumbent short hairs interspersed with several dark brown long upright hairs on prescutellar area; when illuminated in front and viewed dorsally, scutum thickly white pruinose, with 5 longitudinal non-pruinose vittae, of which 1 median vitta is very narrow, 2 submedian and 2 sublateral vittae rather wide (though sublateral vittae somewhat wider than submedian ones), all vittae united with broad transverse band on prescutellar area; when illuminated from behind, scutum having reversed color pattern. Scutellum medium brown, covered with dark brown upright long hairs as well as yellow short hairs. Postnotum dark brown to brownish-black, shiny, whitish-gray pruinose, bare. Pleural membrane bare. Katepisternum dark brown, longer than deep, bare. **Legs.** Foreleg: coxa, trochanter and femur whitish-yellow; tibia whitish-yellow except apical cap light brown, and with whitish sheen widely on outer surface; tarsus dark brown, with moderate dorsal hair crest; basitarsus greatly dilated, 5.62–5.74 times as long as its greatest width. Midleg: coxa dark brown; trochanter and femur whitish-yellow; tibia whitish-yellow except apical cap dark yellow to light brown, and with whitish sheen on posterior surface; tarsus medium brown except basal 4/5 of basitarsus and base of 2nd tarsomere whitish-yellow. Hind leg: coxa dark brown; trochanter and femur whitish-yellow; tibia whitish-yellow except apical cap medium brown, with whitish sheen on posterior surface; tarsus medium-brown except basal 4/5 of basitarsus, and basal 1/2 of 2nd tarsomere yellowish-white; basitarsus (Fig. 22E) nearly parallel-sided, 6.04–6.13 times as long as wide, and 0.67–0.68 and 0.52 times as wide as greatest widths of hind tibia and femur, respectively; calcipala (Fig. 22E) moderately developed, nearly as long as wide, and 0.44 times as wide as greatest width of basitarsus; pedisulcus (Fig. 22E) well developed at basal 1/3 of 2nd tarsomere. All tarsal claws simple, without any tooth. **Wing.** Length 1.9–2.0 mm. Costa with dark spinules and hairs except most hairs of basal patch yellow; subcosta haired except apical 2/5 bare; basal section of radial vein bare;  $R_1$  with dark brown spinules and hairs;  $R_2$  with dark brown hairs; hair tuft on stem vein dark brown; basal cell absent. **Abdomen.** Basal scale light yellow to light brown, with fringe of pale hairs. Dorsal surface of abdomen medium brown except basal 1/4–1/2 of 2nd segment yellowish, with dark brown short hairs and yellow short ones; tergite 2 shiny, white iridescent when illuminated, and tergites 6–8 shiny. Ventral surface of 7th segment with large weakly sclerotized sternal plate medially. **Genitalia.** Sternite 8 (Fig. 22F) with 21–30 dark medium-long to long stout hairs and pale 4 or 5 short to medium-long hairs on each lateral surface. Ovipositor valves (Fig. 22F) triangular, rounded posteromedially, widely separated from each other, membranous except inner margins moderately sclerotized, moderately covered with microsetae and 6–8 pale and dark short to medium-long hairs except narrow portion along posterior margin bare; inner margin widely concave. Genital fork (Fig. 22G) of inverted-Y form, with narrow well sclerotized stem; arms of moderate width, each with distinct projection directed anterodorsally. Paraproct in ventral view (Fig. 22H) nearly triangular, moderately sclerotized on outer surface, weakly sclerotized on narrow part of anteromedial surface, with 29–35 pale and dark short to long hairs on lateral and ventral surfaces, and with 2 or 3 short sensilla on anteromedial surface; paraproct in lateral view (Fig. 22I) much shorter than wide, and much protruding ventrally beyond ventral margin of cercus. Cercus in lateral view (Fig. 22I) short, 0.6 times as long as wide, with numerous medium-long to long hairs, and rounded posteriorly. Spermatheca (Fig. 22J) nearly ovoid, 1.3 times as long as greatest width, well sclerotized except small portion of junction with duct unsclerotized, appearing to bear very faintly defined reticulate patterns on its surface; internal setae present; accessory ducts subequal in thickness to each other, and slightly thicker than major duct.

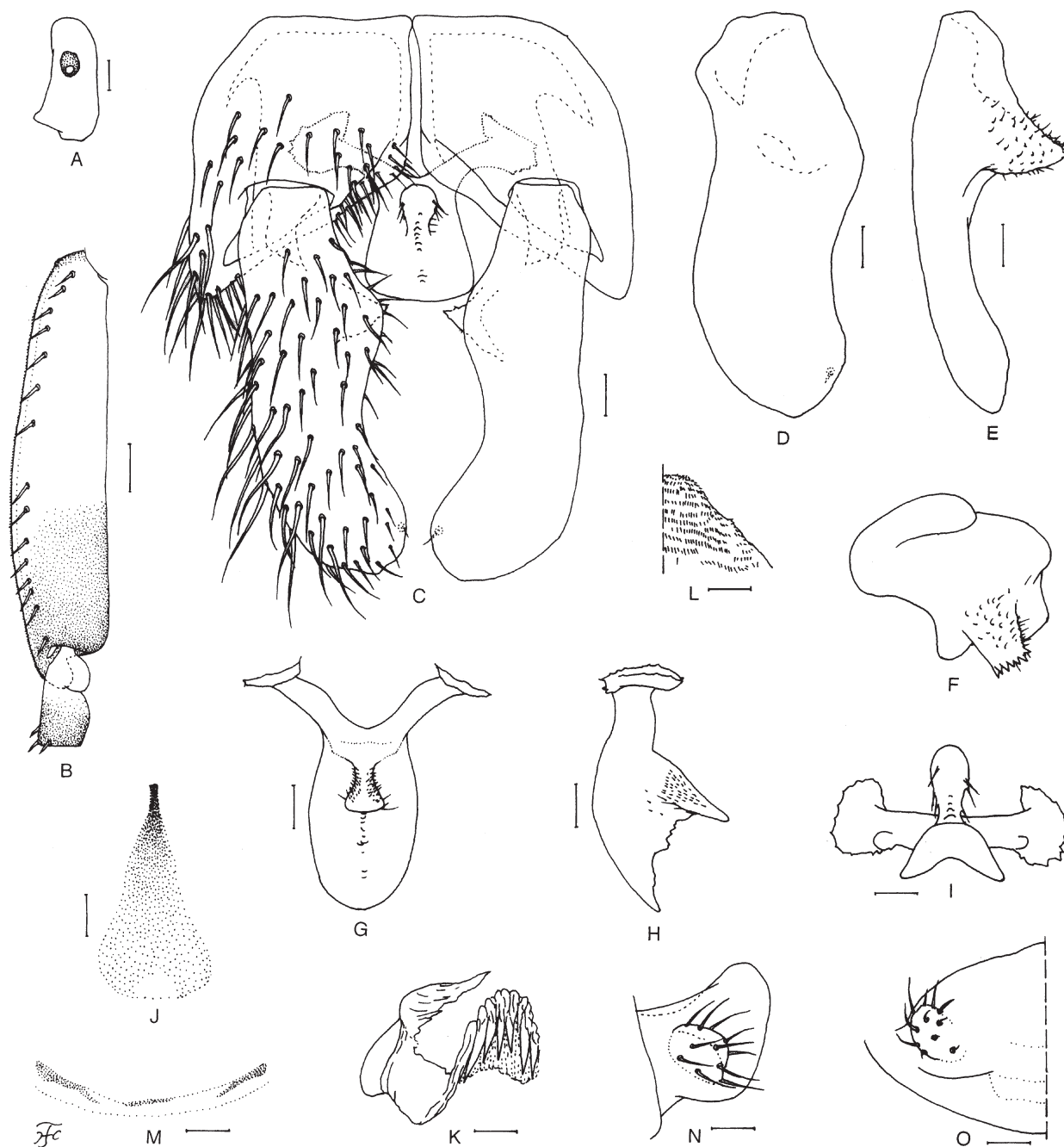


**FIGURE 22.** Female of *Simulium* (*Simulium*) *tamorense* sp. nov. A, fronto-ocular area (right side; front view); B & C, 3rd segments of maxillary palp showing opening of sensory vesicle of different size (right side; front view); D, upper part of cibarium; E, basitarsus and 2nd tarsomere of hind leg (left side; outer view); F, 8th sternite and ovipositor valves (ventral view); G, genital fork (ventral view); H & I, paraproct and cercus (right side; H, ventral view; I, lateral view); J, spermatheca (lateral view). Scale bars. 0.05 mm for E; 0.02 mm for A–D & F–J.

**Male.** Body length 2.0 mm. **Head.** Width subequal to that of thorax. Upper eye consisting of large facets in 14 vertical columns and in 15 horizontal rows. Clypeus brownish-black, whitish-gray pruinose, not shiny, covered with dark brown hairs along and near lateral margins (most of central portion bare). Antenna composed of scape, pedicel and 9 flagellomeres, yellow on scape, pedicel and 1st flagellomere, and light to dark brown on rest flagellomeres in anterior view, and yellow on scape and pedicel and light to dark brown on all flagellomeres though base of 1st flagellomere yellow in posterior view; 1st flagellomere elongate, 1.69 times as long as 2nd one. Maxillary palp light brown, composed of 5 segments with proportional lengths of



3rd, 4th, and 5th segments 1.00:1.09:2.34; 3rd segment (Fig. 23A) of normal size; sensory vesicle (Fig. 23A) small (0.21–0.23 times as long as 3rd segment), nearly globular, and with small opening. **Thorax.** Scutum dark brown except anterolateral calli light brown, thickly whitish-gray pruinose (widely at least along each lateral margin and on prescutellar area, though border between pruinose and non-pruinose areas not well discernible due to thick covering of yellow short hairs) and shiny when illuminated at certain angle of light; scutum uniformly and densely covered with yellow recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Scutellum dark brown, shiny, with several dark brown long upright hairs as well as yellow short hairs. Postnotum, pleural membrane and katepisternum as in female. **Legs.** Color similar to that of female except mid basitarsus yellow with apical 1/4 light brown, hind femur yellow with apical cap light brown, hind tarsus light to medium brown with basal 3/5 of basitarsus and basal 1/2 of 2nd tarsomere yellow; fore basitarsus moderately dilated, 5.40 times as long as its greatest width; hind basitarsus (Fig. 23B) much enlarged, gradually widened toward apical 1/3, then slightly narrowed toward apex, 4.13 times as long as its greatest width, and 0.79 and 0.73 times as wide as greatest widths of hind tibia and femur, respectively; calcipala well developed, nearly as long as wide and 0.33 times as wide as greatest width of basitarsus; pedisulcus well developed. **Wing.** Length 2.0 mm; other characters as in female except subcosta bare. **Abdomen.** Basal scale dark brown, with fringe of dark long hairs. Dorsal surface of abdomen medium to dark brown except basal 2/3 of 2nd segment yellow to light brown, with dark brown short to medium-long hairs and yellow short hairs; segments 2 and 6–9 each with pair of shiny white-pruinose (even silvery iridescent when illuminated at certain angle of light) spots dorsolaterally, those on segment 2 connected broadly to each other in middle. **Genitalia.** Coxite in ventral view (Fig. 23C) nearly quadrate though protruding posterolaterally. Style in ventral view (Fig. 23C) elongate, 1.37 times as long as coxite, somewhat widened from base to basal 1/3, then nearly parallel-sided toward apex, and with rounded apex, without apical or subapical spine (though short slender seta present); style in ventrolateral view (Fig. 23D) elongate, 2.82 times as long as its greatest width near basal 1/3, nearly parallel-sided from basal 1/3 to apex, with lateral margins sinuous; style in medial view (Fig. 23E) flattened dorsoventrally, with medium-long triangular protuberance near base on dorsal surface, bearing several small spinules on its anterior surface and at apex; style in end view (Fig. 23F) with broad subbasal protuberance bearing apex truncated and several spinules lying along apical margin. Ventral plate in ventral view (Fig. 23C) with base nearly rectangular (though somewhat narrowed basally, and rounded on each posterolateral corner), bearing anteromedial projection directed ventrally which is moderately covered with minute setae anterolaterally and very sparsely posterolaterally, and almost bare posteromedially; arms short, stout, with widened apex, divergent from each other at angle of ca. 120 degrees; ventral plate in anteroventral view (Fig. 23G): base flat, elliptical, bearing medial projection directed ventrally; ventral plate in lateral view (Fig. 23H): base tapered posteriorly bearing its ventral margin irregularly ragged and few setae on each side near base of anteromedian projection, which is tapered ventrally and moderately covered with minute setae on each anterolateral surface; ventral plate in end view (Fig. 23I): base rounded ventrally and concave dorsally, bearing median projection with rounded apex and constricted base and with few setae on and near each lateral margin. Median sclerite (Fig. 23J) plate-like, narrow at base, then widened toward apex, with wide round apex; median sclerite dark brown basally, light to medium brown medially and apically except medial small portion at apex unpigmented. Paramere (Fig. 23K) wide basally, with 6 distinct hooks. Aedeagal membrane (Fig. 23L) moderately covered with minute setae; dorsal plate (Fig. 23M) weakly pigmented only laterally and medially. Abdominal segment 10 (Fig. 23N,O) without any distinct hair on ventral and lateral surfaces. Cercus (Fig. 23N,O) small, rounded, with 10 or 11 distinct hairs.



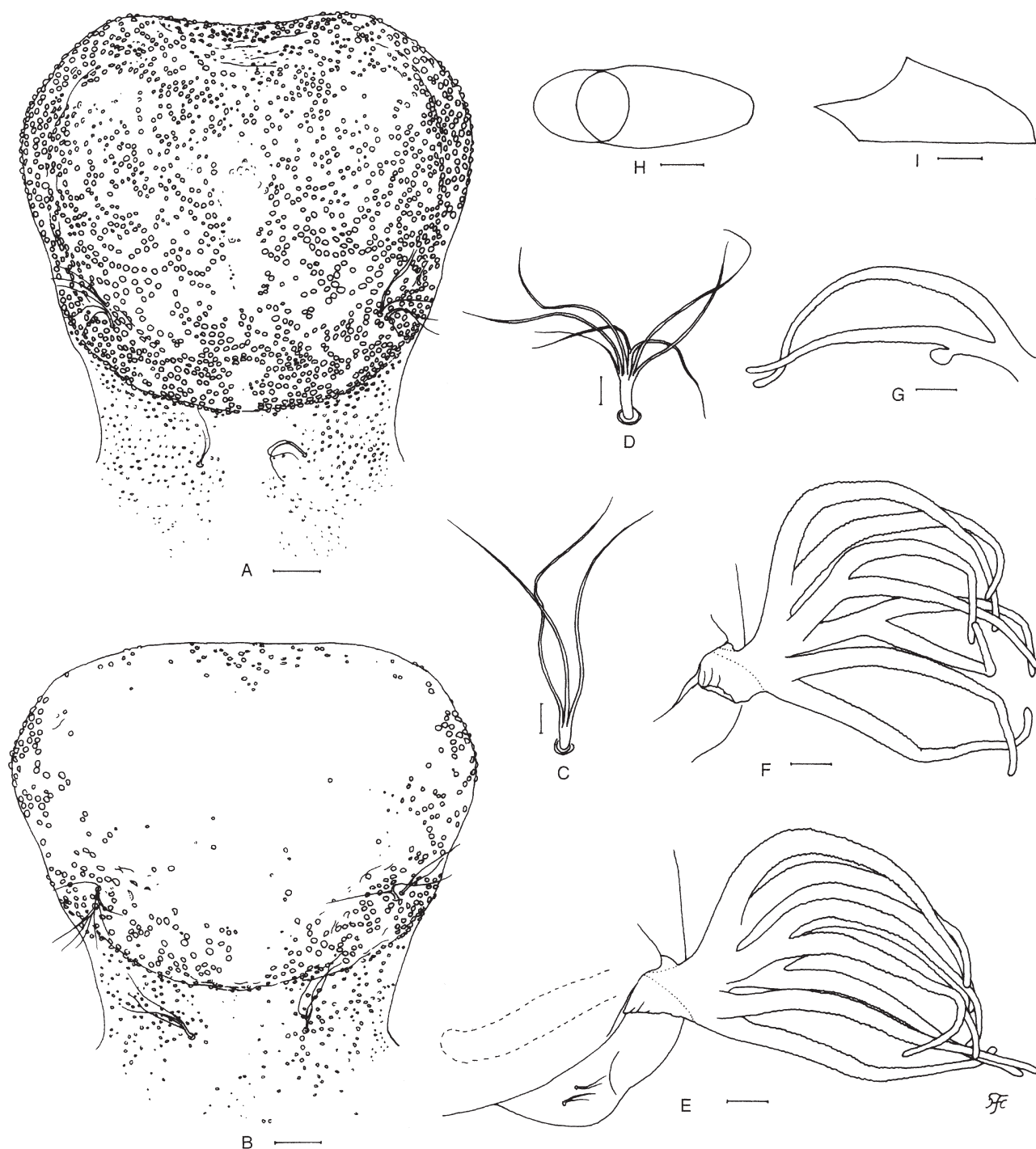
**FIGURE 23.** Male of *Simulium* (*Simulium*) *tamorense* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (left side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D–F, styles (right side; D, ventrolateral view; E, medial view; F, end view); G–I, ventral plates (G, anteroventral view; H, lateral view; I, end view); J, median sclerite (end view); K, paramere with several hooks (right side; end view); L, aedeagal membrane (left half; end view); M, dorsal plate (ventral plate); N & O, 10th abdominal segment with cercus (right side; N, lateral view; O, end view). Scale bars. 0.05 mm for B; 0.02 mm for A & C–O.

**Pupa.** Body length 2.2–2.6 mm. **Head.** Integument yellow to yellowish-brown; frons somewhat raised along ventral and lateral margins, moderately covered with round tubercles in male pupal exuviae (Fig. 24A) or almost bare except moderately or sparsely covered with round tubercles near margins in female pupal exuviae (Fig. 24B); antennal sheaths almost bare in female pupal exuviae or sparsely covered with tubercles in male pupal exuviae; frons with 2 pairs of medium-long trichomes each with 2–4 branches (Fig. 24A,B); face almost bare except small area near dorsal margin moderately covered with small tubercles, and with pair of medium-long trichomes with 2 or 3 branches (Fig. 24C). **Thorax.** Integument yellow to yellowish-brown, moderately covered with round tubercles of various sizes except dorsal surface of posterior 1/4 covered with

small cone-like tubercles with pointed apices; thorax on each side with 3 medium-long trichomes each with 4–9 branches (Fig. 24D) mediodorsally, 2 medium-long trichomes each with 3 or 4 branches anterolaterally, 1 medium-long bifid or trifid trichome mediolaterally, and 3 medium-long trichomes each with 2–6 branches ventrolaterally. Gill (Fig. 24E,F) with 8 short filaments in 4 pairs (1 dorsal, 2 middle and 1 ventral) arising from short common basal stalk; dorsal pair short-stalked, ventral pair almost sessile, and 2 middle pairs with short to medium-long stalks (variable in length among pupal exuviae), which are always nearly as long as or somewhat longer than stalk of dorsal pair (Fig. 24E,F); stalk of dorsal pair and lower filament of ventral pair diverged from each other at angle of 90 degrees or slightly more when viewed laterally; lower filament of outer middle pair of male pupal exuviae with very short round nipple-like branch near base (Fig. 24G); all filaments subequal in length (about 0.5 mm long) and thickness to one another (though thickness of filaments slightly variable from one another in some pupal exuviae depending on length of stalks of 2 middle pairs when basal portions were compared); all filaments always thinner than interspiracular trunk; all filaments light yellow to light grayish except apical 2/5 or little more unpigmented, very slightly tapered from base to apical 2/5 or little more, then moderately tapered toward apex, with distinct annular ridges and furrows (which are though indistinct on basal short portion and apical unpigmented portions), and densely covered with minute tubercles. **Abdomen.** Dorsally, all segments almost transparent and without tubercles; segment 1 with 1 medium-long simple or bifid slender seta on each side; segment 2 with 1 medium-long simple slender seta, 5 very short stout spinous setae on each side; segments 3 and 4 each with 4 distinct simple hooks and 1 short simple seta on each side; segments 5–9 lacking spine-combs (though comb-like groups of minute spines present on segments 6–8); segment 9 without terminal hooks. Ventrally, segments 3–8 each with comb-like groups of minute spines; segment 4 with few slender minute setae on each side; segment 5 with pair of bifid stout hooks submedially and few simple short setae on each side; segments 6 and 7 each with pair of simple inner and outer stout hooks and few simple short setae on each side. Grapnel-shaped hooklets absent on each side of segment 9. **Cocoon** (Fig. 24H,I). Shoe-shaped with anterior collar, thinly to moderately woven except anterior margin thickly woven, without anterolateral window(s) on each side, not extending ventrolaterally; individual threads invisible; light yellow; 2.1–2.5 mm long (excluding length of collar) by 1.0–1.2 mm wide; collar 0.5 mm long by 0.4–0.6 mm high.

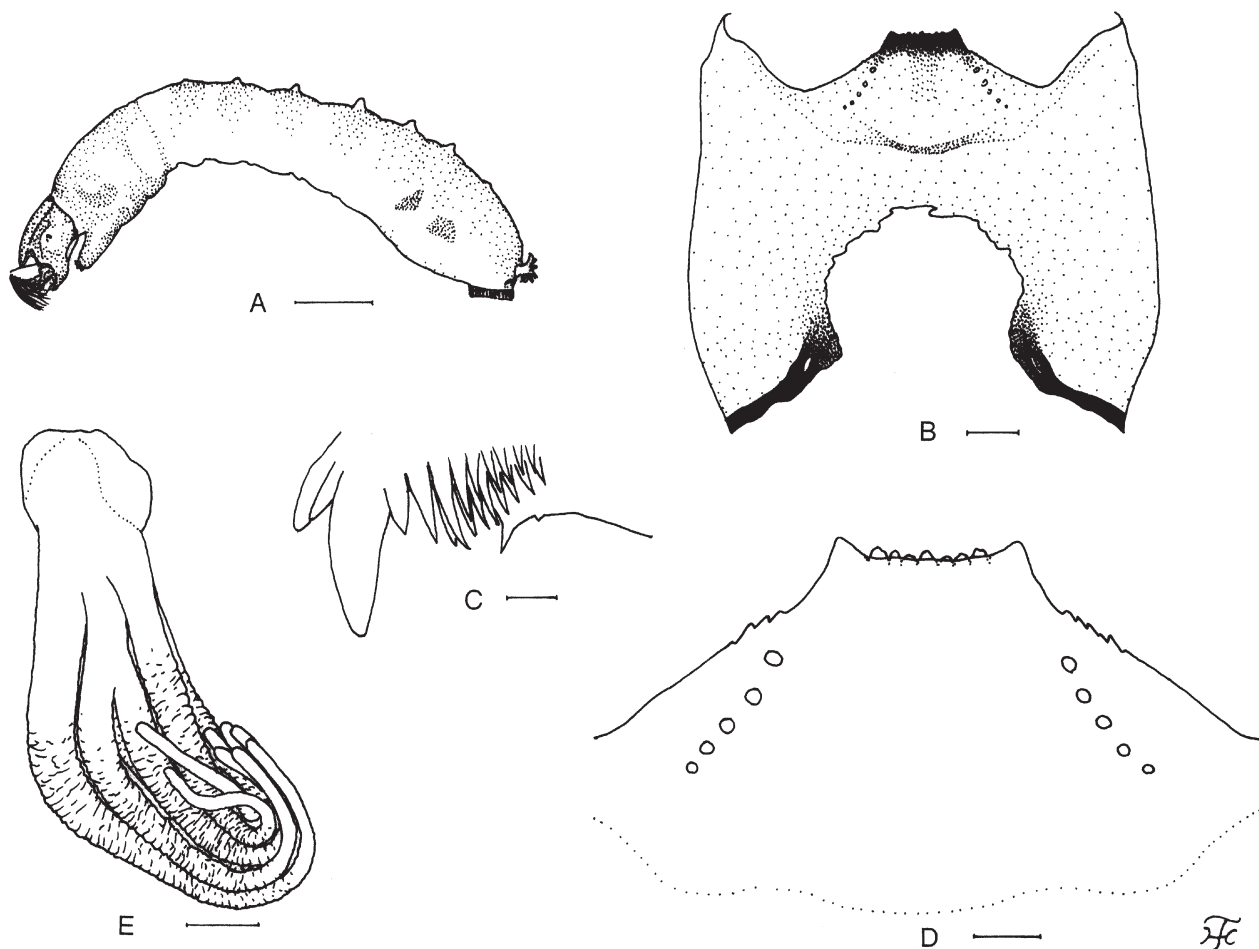
**Mature larva.** Body length 3.8–4.1 mm. Body grayish. Abdomen (Fig. 25A) gradually widened from segment 1 to segment 7, then narrowed to segment 9. Cephalic apotome yellowish-brown except narrow area along posterior margin medium to dark brown with median dark portion slightly extended forward; head spots indistinct or very faintly negative; lateral surface of head capsule dark yellow to yellowish-brown except eye-spot region yellowish and area above eye-spot region light to medium brown, and with 2 or 3 faintly positive or negative isolated spots below eye-spot region and 2 faintly negative large spots before posterior margin; ventral surface of head capsule (Fig. 25B) light yellowish-brown to medium brown except each side of basal portion of postgenal cleft dark brown (though narrow area along posterior margin of hypostoma yellowish in 1 larva). Antenna composed of 3 segments and apical sensillum, slightly longer than stem of labral fan; length ratio of 3 segments (from base to tip) 1.00:1.09–1.16:0.63–0.68. Labral fan with 38–42 main rays. Mandible (Fig. 25C) with mandibular serrations composed of 2 teeth (1 medium-sized and 1 small); main tooth at obtuse angle against mandible on apical side; supernumerary serrations absent; comb-teeth composed of 8 or 9 teeth, increasing in length from 1st to 3rd. Hypostoma (Fig. 25D) with 9 anterior teeth, of which corner teeth most prominent, longer than median tooth; 3 intermediate teeth on each side small, subequal in length to one another; lateral margins weakly serrate apically; 5 hypostomal bristles divergent posteriorly from lateral border on each side. Postgenal cleft (Fig. 25B) large, rounded, 3.75–4.57 times as long as postgenal bridge; subesophageal ganglion not pigmented. Histoblast of pharate pupal gill (Fig. 25E) with 8 short filaments. Thoracic and abdominal cuticle bare except last segment of abdomen moderately covered with short colorless spinous setae on each side of anal sclerite; abdominal segments 1–7 each with pair of round dorsolateral protuberances though those on segments 1 and 7 much smaller than those on segments 2–6 and those on segment 7 appearing to be absent in 2 larvae. Rectal scales appearing to be absent. Rectal organ compound, each lobe with 10–14 finger-like secondary lobules. Anal sclerite X-shaped, with short broad anterior arms about half as long as posterior ones and with forked apices. Last abdominal segment somewhat bulged laterally and lacking ventral papillae. Posterior circlet with 115–125 rows of hooklets with up to 19 hooklets per row.

**Type specimens.** Holotype female (with its associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a rapid-flowing river (width over 10 m, water temperature 17.0°C, exposed to the sun, altitude 651 m, 28°78'67.3" N, 83°73'38.7" E), Tamor, Taplejung, Nepal, 22.III.2010. Paratypes: 2 females and 1 male, with their associated pupal exuviae and cocoons, and 3 mature larvae (all preserved in 80% ethanol), same data and date as those of the holotype.



**FIGURE 24.** Pupa of *Simulium* (*Simulium*) *tamorense* sp. nov. A & B, frons and upper part of face with 2 pairs of frontal trichomes and pair of facial trichomes showing difference in coverage of tubercles on frons between sexes (A, male; B, female); C, trifid facial trichome; D, trichome with 7 branches on mediodorsal surface of thorax; E & F, gills with 8 short filaments showing difference in length of stalks of 2 middle pairs among pupae (right side; outer view); G, 2 filaments of middle pair showing short branch budding from ventral filament; H & I, cocoons (H, dorsal view; I, lateral view). Scale bars. 0.5 mm for H & I; 0.05 mm for A, B & E–G; 0.01 mm for C & D.





**FIGURE 25.** Mature larva of *Simulium (Simulium) tamorense* **sp. nov.** A, whole body of larva showing protuberances on dorsal surface of abdomen (lateral view); B, head capsule showing large round postgenal cleft (ventral view); C, apical portion of mandible; D, hypostoma; E, histoblast of pharate pupal gill (left side; outer view). Scale bars. 0.5 mm for A; 0.05 mm for B & E; 0.02 mm for D; 0.01 mm for C.

**Biological notes.** The pupae of *S. (S.) tamorense* **sp. nov.** were collected from fallen tree leaves in the water. Associated species were *S. (S.) indicum* Becher and *S. (S.) multistriatum* species-group.

**Etymology.** The specific name *tamorense* refers to the name of the locality, Tamor, where this new species was collected.

**Remarks.** According to the keys (Takaoka 2003), *S. (S.) tamorense* **sp. nov.** is assigned to the *multistriatum* species-group of the subgenus *Simulium* s. str. in having the scutum with five longitudinal vittae, simple claws in the female, the style with long basal protuberance (Fig. 23E) in the male, the gill with eight filaments (Fig. 24E) in the pupa, and the postgenal cleft very large and rounded in the larva (Fig. 25B).

This new species is striking in having several characteristics which have been never or rarely found in this species-group: i.e., inner margins of the female ovipositor valves are sclerotized and well defined (Fig. 22F) (c.f., transparent and not well defined); the median process of the male ventral plate located anteriorly (Fig. 23C) (c.f., located medially or posteriorly); the pupal gill filaments very short, about 0.5 mm long (Fig. 24E) (c.f., length of filaments over 0.9 mm); spine-combs on the pupal abdominal segment 8 absent (c.f., present); the larval mandibular comb-teeth increasing in length from the first to third tooth (Fig. 25C) (c.f., decreasing) and paired protuberances on the larval abdomen present (c.f., absent except one known species, *S. (S.) hirtinervis* Edwards from Peninsular Malaysia—Takaoka & Davies 1995). These characteristics easily separate this new species from all known species in this species-group.

In having a shoe-shaped cocoon without any window or open space, this new species appears to be similar to *S. (S.) chaliowae* Takaoka & Boonkemtong, *S. (S.) chainarongi* Kuvangkadilok & Takaoka and *S. (S.) takense* Takaoka & Choochote, all from Thailand (Takaoka & Kuvangkadilok 1999; Takaoka & Choochote 2005c).



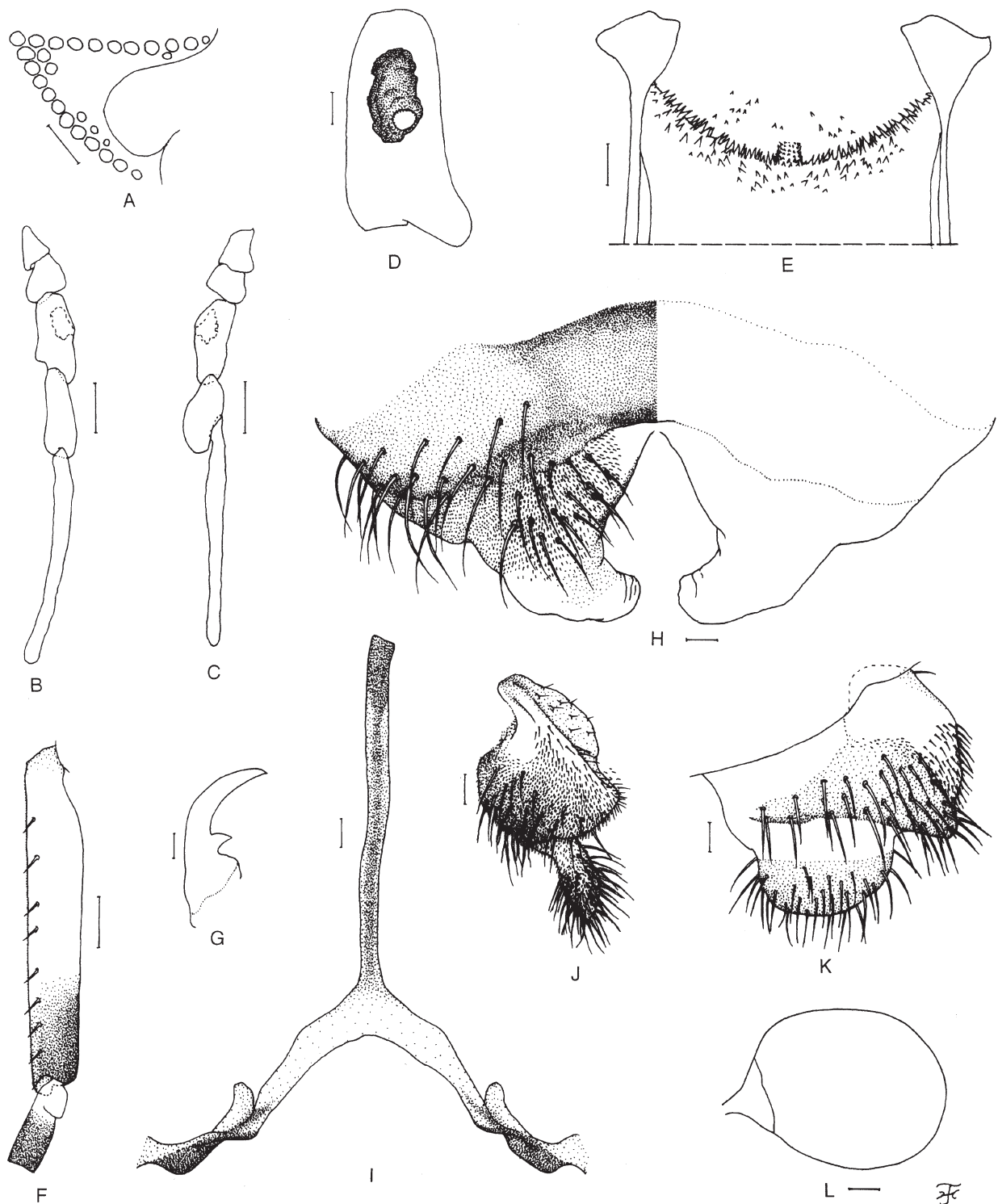
(iii) *Variegatum* species-group

*Simulium (Simulium) tulshii* Takaoka & Shrestha sp. nov.

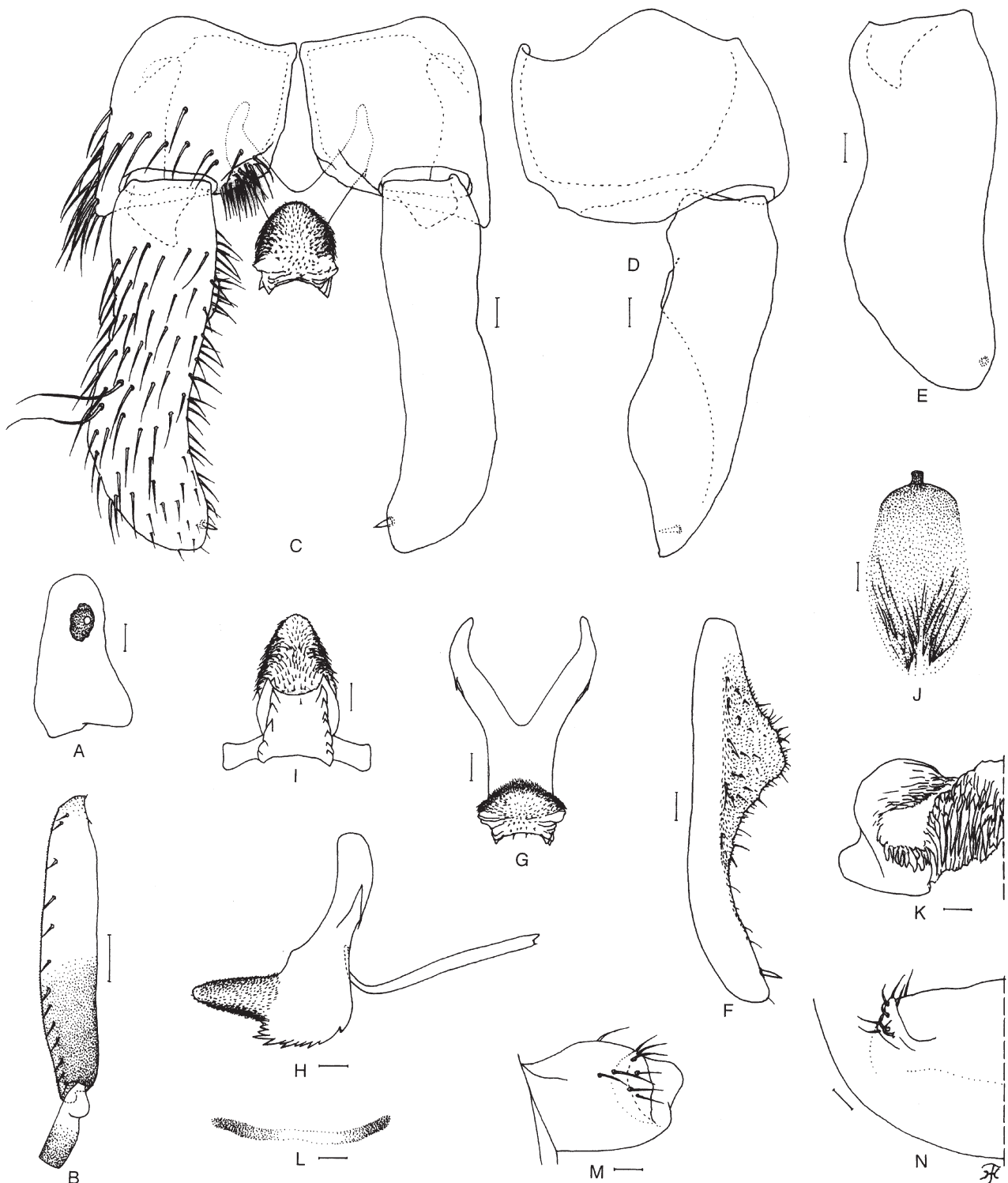
**Description. Female.** Body length 2.8–3.5 mm. **Head.** Narrower than thorax. Frons brownish-black, whitish-gray pruinose, very slightly shiny when illuminated at certain angle of light, and covered with several whitish-yellow and dark brown hairs along each lateral margin and with several whitish-yellow hairs above antennal base; frontal ratio 1.22–1.24:1.00:1.07–1.24; frons-head ratio 1.00:4.14–4.59. Fronto-ocular area (Fig. 26A) well developed, short, directed laterally. Clypeus brownish-black, whitish-gray pruinose, moderately covered with whitish-yellow hairs though small area along dorsal margin bare. Labrum 0.71–0.72 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, medium brown except scape, pedicel and base of 1st flagellomere yellow. Maxillary palp (Fig. 26B) composed of 5 segments, dark brown to brownish-black, proportional lengths of 3rd, 4th and 5th segments 1.00:1.04–1.05:2.45–2.62 (left palp showing abnormality that 5th segment is connected with middle portion of 4th segment as shown in Fig. 26C); 3rd segment (Fig. 26D) somewhat widened apically; sensory vesicle (Fig. 26D) oblong, 0.38–0.43 times as long as 3rd segment, with medium-sized opening. Lacinia with 12–14 inner and 15 or 16 outer teeth. Mandible with 32 inner and 16 outer teeth. Cibarium (Fig. 26E) with small median projection directed posterodorsally, and with numerous sharply pointed processes along posterodorsal margin and even on median projection; similar processes scattered on transparent membrane near posterodorsal margin. **Thorax.** Scutum black, shiny, with whitish-gray pruinose patterns (variable depending of direction of illumination), densely covered with whitish-yellow fine hairs interspersed with dark brown upright hairs on prescutellar area. Scutellum dark brown, with whitish-yellow hairs and dark brown upright hairs. Postnotum dark brown, shiny, whitish-gray pruinose, bare. Pleural membrane bare. Katepisternum longer than deep, blackish, whitish-gray pruinose, shiny when illuminated at certain angle of light, bare. **Legs.** Foreleg: coxa and trochanter whitish-yellow; femur whitish-yellow except apical cap dark yellow to light brown and posterior surface dark yellow; tibia yellowish-white except apical 1/4 dark brown, and with white large sheen on outer surface; tarsus brownish-black, with moderate dorsal hair crest; basitarsus greatly dilated, 6.67 times as long as its greatest width. Midleg: coxa brownish-black; trochanter whitish-yellow with posterior surface partially dark yellow; femur yellow except apical cap dark yellow to light brown; tibia yellowish-white to yellow except apical cap medium brown and mediolongitudinal portion of apical 1/2 to 3/4 of outer surface dark yellow; tibia with white large sheen on posterior surface; tarsus medium brown except little less than basal 1/2 of basitarsus and base of 2nd tarsomere whitish-yellow. Hind leg: coxa dark brown to brownish-black; trochanter yellowish-white; femur medium to dark yellow except base yellowish-white and apical cap medium to dark brown; tibia yellowish-white to yellow except apical cap dark brown and most of outer surface from middle to base of apical cap dark yellow to light brown; tibia with white large sheen on posterior surface; tarsus medium to dark brown except basal 2/3 of basitarsus and little less than basal 1/2 of 2nd tarsomere yellowish-white (Fig. 26F); basitarsus (Fig. 26F) nearly parallel-sided, 6.18 times as long as wide, and 0.68 and 0.57 times as wide as greatest width of hind tibia and femur, respectively; calcipala (Fig. 26F) developed, small, 0.67 times as long as its basal width, and 0.35 times as wide as greatest width of basitarsus; pedisulcus (Fig. 26F) well developed at basal 1/3 of 2nd tarsal segment. Claw with small subbasal tooth (Fig. 26G). **Wing.** Length 2.7–2.9 mm. Costa with dark spinules and light brown hairs except basal patch of hairs yellow; subcosta with hairs except apical 1/3 to 1/2 bare; basal section of radial vein bare;  $R_1$  with dark spinules and hairs;  $R_2$  with hairs; hair tuft on stem vein yellow; basal cell absent. **Abdomen.** Basal scale medium to dark brown, with fringe of pale hairs. Dorsal surface of abdomen dark brown to brownish-black except basal 1/2 to 3/5 of 2nd segment dark yellow, moderately covered with yellow fine short hairs intermixed with short to medium-long dark brown hairs; tergite 2 shiny, white iridescent when illuminated, and tergites 6–8 shiny. Ventral surface of segment 7 with pair of round weakly sclerotized sternal plates. **Genitalia.** Sternite 8 (Fig. 26H) with 18–27 whitish-yellow medium-long to long stout hairs on each lateral surface. Ovipositor valves (Fig. 26H) large, produced posteromedially, with rounded apices, membranous, covered with numerous microsetae and 14–22 whitish-yellow medium-long hairs per side, except apical 1/3 or more bare; inner margins widely concave; narrow portion along inner margin moderately sclerotized and central portion of apical bare portion weakly

sclerotized. Genital fork (Fig. 26I) of inverted-Y form, with narrow well-sclerotized stem; arms of moderate width, each with distinct projection directed anterodorsally. Paraproct in ventral view (Fig. 26J) with shallow groove medially on ventral surface nearly along anteromedial margin, with moderately sclerotized anteromedial surface bearing 9 or 10 sensilla, with numerous short to medium-long hairs on lateral and ventral surfaces; paraproct in lateral view (Fig. 26K) nearly triangular, moderately protruding ventrally beyond cecus, with shallow groove along ventral margin, and with numerous short to medium-long hairs on posterior 1/2. Cercus in lateral view (Fig. 26K) rounded posteriorly, 0.60 times as long as wide, with numerous short and medium-long hairs. Spermatheca (Fig. 26L) nearly ovoid, well sclerotized except portion at junction with duct unsclerotized, without distinct reticulate pattern on its surface, and with internal setae; accessory ducts subequal in thickness to each other, and subequal to, or slightly thicker than, major duct.

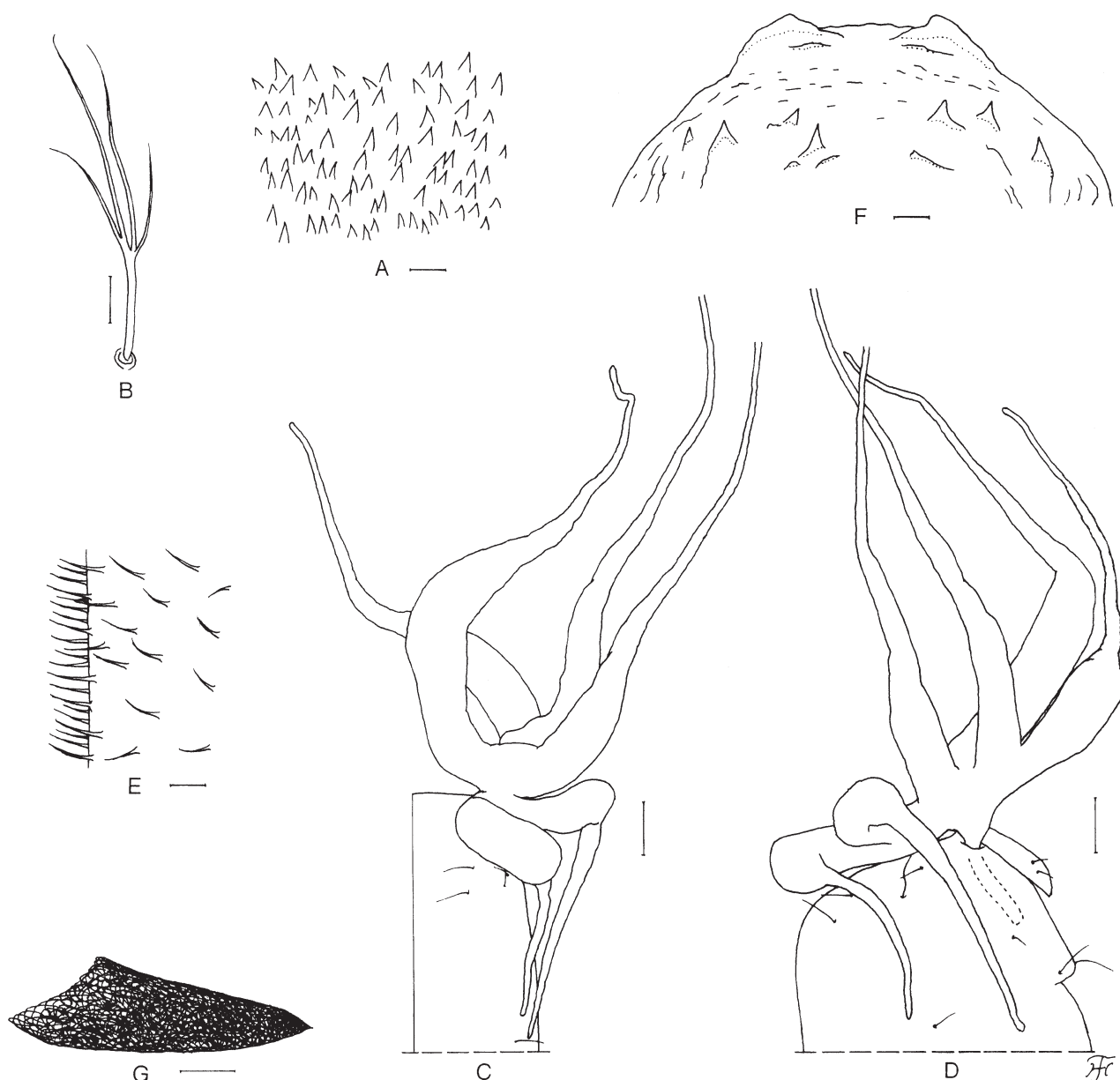
**Male.** Body length 2.7–3.6 mm. **Head.** Wider than thorax. Upper eye consisting of large facets in 21 vertical columns and in 23 horizontal rows. Clypeus black, thickly white pruinose, covered with whitish-yellow hairs along and near lateral margins (most of central portion bare). Antenna composed of scape, pedicel and 9 flagellomeres, medium brown except scape and pedicel dark yellow and base of 1st flagellomere whitish-yellow; 1st flagellomere elongate, 1.9 times as long as 2nd one. Maxillary palp dark brown, composed of 5 segments with proportional lengths of 3rd, 4th, and 5th segments 1.00:1.17:2.73; 3rd segment (Fig. 27A) of normal size; sensory vesicle (Fig. 27A) small, ellipsoidal, 0.24 times as long as 3rd segment, and with small opening. **Thorax.** Scutum black, with whitish-gray pruinose pattern, i.e., anterior pair of large spots on shoulders extending posteriorly along lateral margins and connected to large transverse spot entirely covering prescutellar area; either anterior or posterior 1/2 of large pruinose spot on each shoulder disappearing depending on angle of light; some pruinose areas shiny when illuminated at certain angle of light; scutum uniformly and moderately covered with whitish-yellow recumbent short hairs interspersed with dark brown long upright hairs on prescutellar area. Scutellum medium brown, with several dark long upright hairs as well as whitish-yellow short hairs. Postnotum, pleural membrane and katapisternum as in female. **Legs.** Color nearly as in female except hind basitarsus whitish-yellow on little more than basal 1/2 (Fig. 27B); fore basitarsus moderately dilated, 7.62 times as long as its greatest width; hind basitarsus (Fig. 27B) slightly enlarged, nearly parallel-sided (though apical 1/4 somewhat tapered apically), 5.16 times as long as its greatest width, and 0.73 and 0.76 times as wide as greatest widths of hind tibia and femur, respectively; calcipala (Fig. 27B) small, 0.67 times as long as its basal width and 0.32 times as wide as greatest width of basitarsus; pedisulcus (Fig. 27B) well marked. **Wing.** Length 2.6 mm; other characteristics as in female except subcosta bare. **Abdomen.** Basal scale brownish-black, with fringe of whitish-yellow long hairs. Dorsal surface of abdomen dark brown to brownish-black, moderately covered with whitish-yellow fine short hairs intermixed with dark brown short to medium-long hairs; segments 2 and 4–7 each with pair of whitish-gray pruinose spots dorsolaterally, those on segment 2 connected broadly to each other in middle; ventral surface of abdomen medium to dark brown. **Genitalia.** Coxite in ventral view (Fig. 27C) nearly quadrate, 1.20 times as long as wide; coxite in lateral view (Fig. 27D) 0.79 times as long as wide. Style in ventral view (Fig. 27C) elongate, slightly sinuous, nearly parallel-sided, 1.83 times as long as coxite, with subapical spine; style in lateral view (Fig. 27D) spatulate dorsoventrally, tapered from apical 1/4 to apex; style in ventrolateral view (Fig. 27E) widest little beyond middle, 0.36 times as wide as long; style in medial view (Fig. 27F) with short subbasal bulge directed dorsally, bearing no spinule on its surface. Ventral plate in ventral view (Fig. 27G) Y-shaped, covered with setae densely on anterior surface and moderately on posterior surface of ventrally produced process which bearing 2 vertical rows of spines on posterior surface; arms diverged basally from each other at angle of 60 to 90 degrees, then directed forward; ventral plate in lateral view (Fig. 27H) with distinct serrated posterior margin and densely covered with minute setae on ventrally produced process; ventral plate in end view (Fig. 27I) having 2 vertical rows of 7–9 teeth on posterior surface, and moderately covered with minute setae on ventrally produced elliptical process. Median sclerite (Fig. 27J) well sclerotized, plate-like, wide except near base narrow, with several fissures near apex forming sharply pointed apical tips. Paramere (Fig. 27K) wide basally, with several short to long hooks. Aedeagal membrane very densely covered with minute setae; dorsal plate (Fig. 27L) small, well sclerotized except medial portion incompletely sclerotized. Abdominal segment 10 (Fig. 27M,N) with 0 or 1 distinct hair on ventral surface. Cercus (Fig. 27M,N) small, rounded, with 9–11 distinct hairs.



**FIGURE 26.** Female of *Simulium* (*Simulium*) *tulshii* **sp. nov.** A, fronto-ocular area (right side; front view); B & C, maxillary palps (lateral view; B, normal; C, abnormal in connection of 4th segment with 5th one); D, 3rd segment of maxillary palp with medium-long sensory vesicle (right side; front view); E, upper part of cibarium with numerous pointed processes; F, basitarsus and 2nd tarsomere of hind leg (left side; outer view); G, claw with small basal tooth (lateral view); H, 8th sternite and ovipositor valves (ventral view); I, genital fork (ventral view); J & K, paraproct and cercus (right side; J, ventral view; K, lateral view); L, spermatheca (lateral view). Scale bars. 0.1 mm for B, C & F; 0.04 mm for A; 0.02 mm for D, E & H–L; 0.01 mm for G.



**FIGURE 27.** Male of *Simulium* (*Simulium*) *tulshii* **sp. nov.** A, 3rd segment of maxillary palp with sensory vesicle (right side; front view); B, basitarsus and 2nd tarsomere of hind leg (left side; outer view); C, coxites, styles and ventral plate (ventral view); D, coxite and style (right side; lateral view); E & F, styles (right side; E, ventrolateral view; F, medial view); G, ventral plate (anteroventral view); H, ventral plate and median sclerite (lateral view); I, ventral plate (end view); J, median sclerite (end view); K, paramere with several hooks (right side; end view); L, dorsal plate (ventral view); M & N, 10th abdominal segment with cercus (right side; M, lateral view; N, end view). Scale bars. 0.1 mm for B; 0.02 mm for A & C–N.



**FIGURE 28.** Pupa of *Simulium* (*Simulium*) *tulshii* **sp. nov.** A, tubercles with pointed apices on frons; B, facial trichome with 4 branches; C & D, anterior parts of thorax showing trichomes and gill with inflated filaments (right side; C, dorsal view; D, outer view); E, fine spinous processes on inflated portion of filaments; F, abdominal segment 9 showing distinct spines and pair of blunt terminal hooks (dorsal view); G, cocoon (lateral view). Scale bars. 1.0 mm for G; 0.1 mm for C & D; 0.02 mm for B & F; 0.01 mm for A & E.

**Pupa.** Body length 3.0–3.5 mm. **Head.** Integument including antennal sheaths yellow to dark yellow, densely and elaborately covered with small round tubercles except most tubercles on frons with pointed apices (Fig. 28A); frons with 2 pairs of simple or bifid long stout trichomes somewhat separated from each other in some pupae; face with pair of bifid, trifid or quadrifid long stout trichomes (Fig. 28B). **Thorax.** Integument yellow to dark yellow, densely and elaborately covered with small round or cone-shaped tubercles except most tubercles on dorsal and dorolateral surfaces bearing pointed apices similar to those on frons; thorax on each side with 2 simple, bifid or trifid, long stout trichomes anterodorsally, 2 simple, bifid or trifid stout trichomes (1 long, 1 medium-long) anterolaterally, 1 simple long stout trichome mediolaterally, and 3 simple or bifid stout trichomes (1 short or medium-long, 2 long) ventrolaterally. Gill (Fig. 28C,D) with 6 short inflated filaments arranged as 2+1+1+2 from dorsal to ventral; dorsal and ventral pairs each with short stalk; 2 filaments of dorsal pair directed upward, abruptly turned outward and downward, then directed posteriorly



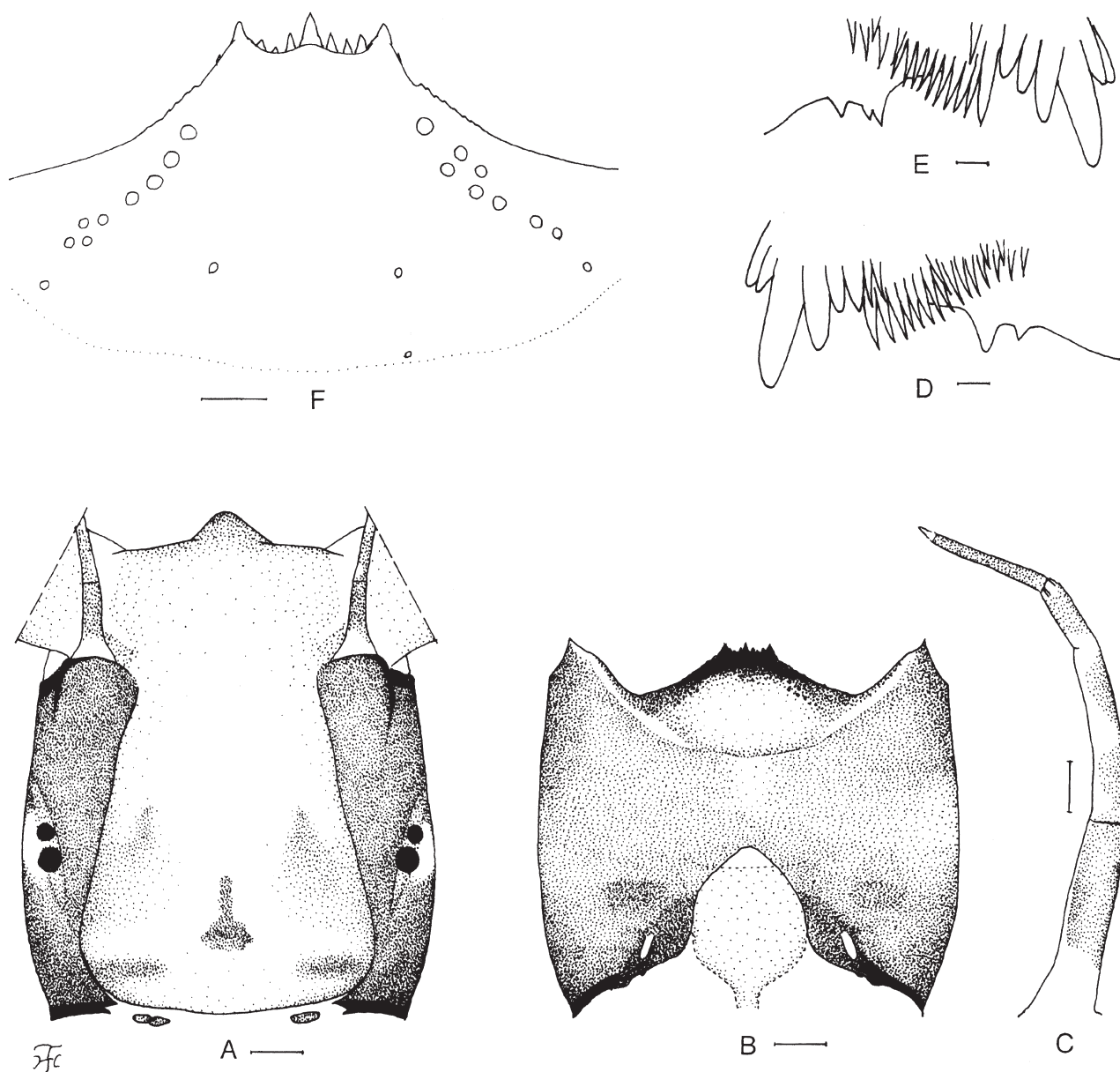
(extending up to abdominal segment 2 in 1 pupa) or inwardly or laterally, and tapered toward apex after curving downward; outer filament of 2 individual filaments directed forward and gradually tapered toward apex, inner filament directed downward and forward, and tapered from basal 1/3 toward apex; dorsal filament of ventral pair directed forward, and gradually tapered toward apex, ventral filament of ventral pair directed downward, inward and forward, and first widened to varying extent from base, then tapered from middle or apical 2/3 to apex (length of apical slender portion variable among individual pupae); all filaments variable in length (1.6–2.4 mm), nearly transparent to light ochreous, moderately covered with minute slender spinous processes on inflated portion and parts of slender portion (though spinous processes becoming shorter and fewer on slender portions) (Fig. 28E), and densely covered with minute tubercles on entire surface. **Abdomen.** Dorsally, segment 1 weakly sclerotized, light ochreous, moderately covered with minute spines, with 1 simple or bifid medium-long seta on each side; segment 2 transparent or somewhat light ochreous, moderately covered with minute spines, with 1 simple medium-long seta and 5 simple short stout spines on each side; segments 3 and 4 transparent, each with 4 distinct simple hooks and 1 short simple seta on each side; segments 5 and 6 transparent, lacking spine-combs (though segment 6 with spine-combs in 1 pupa); segments 7–9 each with distinct spine-combs in transverse row (though those on segment 9 much smaller in 1 pupa), and also comb-like groups of minute spines on each side; segment 9 with pair of terminal hooks of irregular form (Fig. 28F). Ventrally, segments 3–8 transparent, each with comb-like groups of minute spines; segment 4 with few short to medium-long somewhat stout setae on each side; segment 5 with pair of simple and/or bifid stout hooks submedially and few simple short setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer stout hooks somewhat separated from each other and few simple short setae on each side. Grapnel-shaped hooklets absent on each side of segment 9. **Cocoon** (Fig. 28G). Shoe-shaped, with very low to low anterior collar, soft, roughly woven, with many small open spaces anteriorly, and not extending ventrolaterally; individual threads visible; light yellow; 4.2–6.8 mm long by 1.6–2.0 mm wide.

**Mature larva.** Body length 9.0 mm. Body grayish. Abdomen gradually widened from segment 1 to segment 7, then narrowed to segment 9. Cephalic apotome (Fig. 29A) yellow except anterior area and narrow areas along lateral and posterior margins, in particular, near mediolateral head spots, light to medium brown; head spots moderately positive though anterior spot of mediolongitudinal spots indistinct; lateral surface of head capsule dark brown except eyes-spot region yellowish, area below eye-spot region to varying extent light brown, and eyebrow area somewhat lighter; ventral surface of head capsule (Fig. 29B) dark brown except most area of hypostoma and parts of postgenal bridge yellow to light brown. Antenna (Fig. 29C) composed of 3 segments and apical sensillum, slightly longer than stem of labral fan; length ratio of 3 segments (from base to tip) 1.0:1.4:0.7; antenna dark brown except base and ventral surface of segment 1, 4 areas (including apex) of segment 2 and apical sensillum unpigmented. Labral fan with 38 main rays. Mandible (Fig. 29D) with mandibular serrations composed of 2 teeth (1 large and 1 medium-sized) (though another small tooth at base of main tooth in right mandible—Fig. 29E); main tooth at obtuse angle against mandible on apical side; supernumerary serrations absent; comb-teeth composed of 4 or 5 teeth, of which 1st tooth longest and others subequal in length to one another (though comb-teeth decreasing in length from 1st to 3rd in right mandible—Fig. 29E). Hypostoma (Fig. 29F) with 9 anterior teeth, of which median tooth longest of all; inner tooth of 3 intermediate teeth on each side longer than 2 others though little shorter than each corner tooth; lateral margins weakly serrate apically; 9 hypostomal bristles divergent posteriorly from lateral border on each side. Postgenal cleft (Fig. 29B), of medium-size, 1.21 times as long as postgenal bridge; subesophageal ganglion well pigmented, wine-glass shaped. Histoblast of pharate pupal gill with 6 inflated filaments. Thoracic and abdominal cuticle bare except abdominal segments 8 and 9 moderately to densely covered with short colorless setae on dorsal and lateral surfaces. Rectal scales present. Rectal organ of 3 simple large lobes, without secondary lobules. Anal sclerite X-shaped, with short broad anterior arms 0.73 times as long as posterior ones and with forked apices. Last abdominal segment not bulged laterally and lacking ventral papillae. Posterior circlet with 94 rows of hooklets with up to 22 hooklets per row.

**Type specimens.** Holotype female (with associated pupal exuviae and cocoon) (preserved in 80% ethanol), reared from pupa collected from a small moderately-flowing water canal (water temperature 15.5°C, exposed to the sun, altitude 2,745 m, 28°78'67.3" N, 83°73'38.7" E) Jomsom, Mustang, Nepal, 23.IX.2009. Paratypes: 3 females, 2 males, all with associated pupal exuviae and cocoons, same data as those of holotype;

2 pupae collected from a moderately-flowing very small stream (water temperature 15.0°C, exposed to the sun, altitude 3,448 m, 28°81'80.3" N, 83°84'34.1" E), Jharkot, Mustang, Nepal, 21.IX.2009; 3 mature larvae collected from a rapidly-flowing small stream (water temperature 8.0°C, exposed to the sun, altitude 3,743 m, 28°81'69.7" N, 83°87'14.0" E), Muktinath, Mustang, Nepal, 21.IX.2009.

**Biological notes.** The pupae and larvae of this new species were collected from grass leaves trailing in the water. No other species was collected.



**FIGURE 29.** Mature larva of *Simulium (Simulium) tulshii* sp. nov. A & B, head capsules (A, dorsal view; B, ventral view); C, antenna showing darkly pigmented areas and light unpigmented ones (lateral view); D & E, apical portions of mandibles of the same larva (D, left side; E, right side, with additional small tooth near main mandibular tooth); F, hypostoma. Scale bars. 0.1 mm for A & B; 0.04 mm for C & F; 0.01 mm for D & E.

**Etymology.** The specific name *tulshii* is in honor of Mr. Tulshi Krishna Shrestha, father of the junior author, who kindly accompanied and assisted in field surveys.

**Remarks.** *Simulium (S.) tulshii* sp. nov. is assigned to the *variegatum* species-group of the subgenus *Simulium (Simulium)* redefined by Takaoka (2003) in that it has a combination of the following characteristics: claw with a small subbasal tooth (Fig. 26G), ovipositor valves rounded, with inner margins

widely concave (Fig. 26H) in the female, ventral plate with toothed posterolateral margins (Fig. 27I), style elongate, without a basal protuberance (Fig. 27F) in the male, and six gill filaments (Fig. 28C,D) in the pupa.

This new species is characterized by the female cibarium with numerous spinous processes on and near the posterodorsal margin (Fig. 26E), and the six inflated pupal gill filaments (Fig. 28C,D).

Interestingly, the similar arrangement of six inflated gill filaments has been reported for *S. (S.) flavum* Takaoka, *S. (S.) loreense* Takaoka and *S. (S.) malinoense* Takaoka, all described from Sulawesi, Indonesia, although two filaments directed upward are not curved downward apically in the latter three known species (Takaoka 2003). Apart from the pupal gill filaments, all these three known species are different from *S. (S.) tulshii* **sp. nov.** by many characteristics including the cibarium with few to several minute processes, short ovipositor valves in the female, narrow ventral plate in the male, wall-pocket shaped cocoon, and rectal organ compound, each lobe with several secondary lobules.

## Keys to species of black flies in Nepal

### Females\*

1	Basal portion of radial vein haired .....	2
-	Basal portion of radial vein bare .....	12
2	Postnotum with patch of fine hairs on each side .....	<i>S. jomsomense</i> <b>sp. nov.</b>
-	Postnotum without hairs .....	3
3	Katepisternum haired .....	4
-	Katepisternum bare .....	6
4	Claw with small basal tooth .....	<i>S. bhutanense</i> Takaoka & Somboon
-	Claw with large basal tooth .....	5
5	Hind tibia whitish-yellow on basal 1/2 or more .....	<i>S. nepalense</i> Lewis
-	Hind tibia brownish except base pale .....	<i>S. baglungense</i> <b>sp. nov.</b> , <i>S. bucolicum</i> Datta, <i>S. darjeelingense</i> Datta and <i>S. siamense</i> Takaoka & Suzuki
6	Claw with small basal tooth .....	7
-	Claw with large basal tooth .....	8
7	Fore basitarsus with thick dorsal hair crest; leg bicolored .....	<i>S. indicum</i> Becher
-	Fore basitarsus with moderate dorsal hair crest; leg entirely brownish .....	<i>S. letense</i> <b>sp. nov.</b>
8	Sensory vesicle of medium size, 0.3–0.4 times as long as 3rd maxillary palpal segment .....	9
-	Sensory vesicle elongate, over 0.5 times as long as 3rd maxillary palpal segment .....	10
9	Hind tibia with subbasal dark spot .....	<i>S. aureohirtum</i> Brunetti
-	Hind tibia entirely brownish .....	<i>S. suchitrae</i> <b>sp. nov.</b>
10	Ovipositor valves rounded posteriorly .....	<i>S. nemorivagum</i> Datta
-	Ovipositor valves triangular .....	11
11	Genital fork with anterodorsal projection on each arm .....	<i>S. praelargum</i> Datta
-	Genital fork without any projection on each arm .....	<i>S. gracile</i> Datta and <i>S. purii</i> Datta
12	Claw with small subbasal tooth .....	13
-	Claw simple, without any tooth .....	14
13	Ovipositor valve extended posteromedially, much longer than sternite 8, with rounded apex .....	<i>S. tulshii</i> <b>sp. nov.</b>
-	Ovipositor valve shorter than sternite 8, with pointed apex .....	<i>S. himalayense</i> Puri, <i>S. oitanum</i> (Shiraki) and <i>S. vega</i> Maskey
14	Scutum without any vittae .....	<i>S. pradyai</i> Takaoka, <i>S. ramosum</i> Puri and <i>S. rufibasis</i> Brunetti
-	Scutum with 5 longitudinal vittae .....	15
15	Hind tibia brownish .....	<i>S. bagmaticum</i> Maskey
-	Hind tibia whitish-yellow except apical cap brownish .....	16
16	Ovipositor valves covered with numeros microsetae but lacking short hairs; their inner margins not sclerotized .....	<i>S. hillycum</i> Maskey
-	Ovipositor valves covered with 6–8 short hairs as well as numerous microsetae; their inner margins moderately sclerotized .....	<i>S. tamorense</i> <b>sp. nov.</b>

\**Simulium butwalense* **sp. nov.**, *S. dattai* Takaoka & Somboon, *S. lekhaniense* **sp. nov.**, *S. nuwakotense* **sp. nov.**, *S. sachini* Takaoka & Henry, *S. singtamense* Datta and *S. varicorne* Edwards are not included because the females of these species remain unknown.

## Males\*\*

1	Scutum without distinct whitish pruinose spot on each shoulder.....	2
-	Scutum with distinct whitish pruinose spot on each shoulder.....	13
2	Katepisternum haired.....	3
-	Katepisternum bare.....	8
3	Hind basitarsus enlarged, spindle-shaped or wedge-shaped.....	4
-	Hind basitarsus not enlarged, parallel-sided.....	6
4	Hind basitarsus dark brown except basal 3/10 yellow.....	<i>S. nepalense</i>
-	Hind basitarsus light to medium brown.....	5
5	Ventral plate nearly as long as wide.....	<i>S. darjeelingense</i>
-	Ventral plate 1/2 as long as wide.....	<i>S. nuwakotense</i> <b>sp. nov.</b> and <i>S. sachini</i>
6	Antenna with 8 flagellomeres.....	<i>S. varicorne</i>
-	Antenna with 9 flagellomeres.....	7
7	Fore coxa yellow.....	<i>S. siamense</i>
-	Fore coxa medium brown.....	<i>S. butwalense</i> <b>sp. nov.</b>
8	Style much longer than coxite.....	<i>S. indicum</i>
-	Style shorter than coxite.....	9
9	Ventral plate with median keel.....	10
-	Ventral plate without median keel.....	11
10	Hind basitarsus spindle-shaped.....	<i>S. jomsomense</i> <b>sp. nov.</b>
-	Hind basitarsus parallel-sided.....	<i>S. aureohirtum</i>
11	Paramere with 1 hook.....	<i>S. gracile</i> and <i>S. purii</i>
-	Paramere with several hooks.....	12
12	Upper eye with large facets in 12 vertical columns and 14 horizontal rows.....	<i>S. nemorivagum</i>
-	Upper eye with large facets in 16 vertical columns and 17 horizontal rows.....	<i>S. praelargum</i>
13	Hind tibia yellowish except apical cap brown.....	14
-	Hind tibia almost brownish or brownish with base yellow.....	15
14	Upper eye with large facets in 14 vertical columns and 15 horizontal rows; style with triangular basal protuberance when viewed medially.....	<i>S. tamoreense</i> <b>sp. nov.</b>
-	Upper eye with large facets in 21 vertical columns and 23 horizontal rows; style without any protuberance.....	<i>S. tulshii</i> <b>sp. nov.</b>
15	Hind femur yellow except apical cap brown.....	<i>S. titareense</i> <b>sp. nov.</b>
-	Hind femur mostly brownish.....	16
16	Style with triangular basal protuberance.....	<i>S. hillycum</i>
-	Style without such protuberance.....	17
17	Base of ventral plate saddle-shaped, with rounded posterior margin when viewed ventrally.....	<i>S. bagmaticum</i>
-	Base of ventral plate quadrate or subquadrate when viewed ventrally.....	18
18	Base of ventral plate quadrate; hind basitarsus enlarged, nearly as wide as hind tibia.....	<i>S. pradyai</i> , <i>S. ramosum</i> and <i>S. rufibasis</i>
-	Base of ventral plate subquadrate, much longer than wide; hind basitarsus somewhat enlarged, apparently narrower than hind tibia.....	<i>S. himalayense</i> , <i>S. oitanum</i> and <i>S. vega</i>

\*\* *Simulium baglungense* **sp. nov.**, *S. dattai*, *S. lekhamiense* **sp. nov.**, *S. letense* **sp. nov.**, *S. singtamense* and *S. suchitrae* **sp. nov.** are not included because their males remain unknown.

## Pupae\*\*\*

1	Gill with 4 filaments.....	2
-	Gill with 6 filaments or more.....	6
2	Cocoon simple wall-pocket shaped.....	<i>S. jomsomense</i> <b>sp. nov.</b>
-	Cocoon with anterodorsal projection(s) or with anteroventral collar.....	3
3	Cocoon with anteroventral collar.....	<i>S. letense</i> <b>sp. nov.</b>
-	Cocoon with anterodorsal projection(s).....	4
4	Cocoon with 2 slender anterodorsal projections directed forward and downward and fused into broad flap.....	<i>S. lekhamiense</i> <b>sp. nov.</b>
-	Cocoon with 1 anterodorsal projection.....	5
5	Anterodorsal projection bifurcated.....	<i>S. gracile</i>

- Anterodorsal projection not bifurcated.....	<i>S. purii</i>
6 Gill with 6 filaments .....	7
- Gill with 8 filaments or more.....	15
7 Cocoon shoe-shaped.....	8
- Cocoon wall-pocket shaped.....	9
8 Gill filaments inflated.....	<i>S. tulshii</i> <b>sp. nov.</b>
- Gill filaments not inflated.....	<i>S. indicum</i>
9 Cocoon with anterodorsal projection.....	10
- Cocoon without anterodorsal projection.....	11
10 Six gill filaments widely divergent, shorter than pupal body.....	<i>S. aureohirtum</i>
- Six gill filaments not widely divergent, longer than pupal body.....	<i>S. praelargum</i>
11 Cocoon with anterolateral window on each side.....	<i>S. titarensense</i> <b>sp. nov.</b>
- Cocoon without anterolateral window.....	12
12 Middle pair of filaments closely associated with stalk of dorsal pair of filaments; uppermost and lowermost filaments at acute angle when viewed laterally.....	13
- Middle pair of filaments independently arising between dorsal and ventral pairs of filaments; uppermost and lowermost filaments diverging at obtuse angle when viewed laterally.....	<i>S. himalayense</i> , <i>S. oitanum</i> , <i>S. singtamense</i> and <i>S. vega</i>
13 Thoracic trichomes with branches; six gill filaments directed downward.....	<i>S. ramosum</i>
- Thoracic trichomes simple; six gill filaments directed forward.....	14
14 Thoracic integument almost bare, without tubercles.....	<i>S. pradyai</i>
- Thoracic integument moderately covered with tubercles.....	<i>S. rufibasis</i>
15 Gill with 8 filaments.....	16
- Gill with 10 filaments or more.....	26
16 Cocoon shoe-shaped.....	<i>S. tamorensense</i> <b>sp. nov.</b>
- Cocoon wall-pocket shaped.....	17
17 Cocoon with anterolateral window on each side.....	<i>S. hillycum</i>
- Cocoon without anterolateral window.....	18
18 Gill composed of Y-shaped inflated structure.....	19
- Gill without inflated structure.....	20
19 Dorsal branch of Y-shaped inflated structure with 1 constriction.....	<i>S. sachini</i>
- Dorsal branch of Y-shaped inflated structure with 2 constrictions.....	<i>S. nuwakotense</i> <b>sp. nov.</b>
20 Frons smooth, without tubercles.....	<i>S. baglungense</i> <b>sp. nov.</b>
- Frons covered with tubercles.....	21
21 Two filaments of ventral pair different in thickness from each other.....	22
- Two filaments of ventral pair of equal thickness.....	23
22 Stalk of ventral pair of moderate length.....	<i>S. butwalense</i> <b>sp. nov.</b>
- Stalk of ventral pair very short.....	<i>S. darjeelingense</i>
23 Gill with common basal stalk of short to moderate length; dorsal and middle triplets of filaments sharing common stalk.....	24
- Gill with very short common basal stalk; dorsal and middle triplets of filaments not sharing common stalk.....	25
24 Common stalk of dorsal and middle triplets of filaments slightly shorter than common basal stalk.....	<i>S. bucolicum</i>
- Common stalk of dorsal and middle triplets of filaments much longer than common basal stalk.....	<i>S. varicorne</i>
25 Stalk of ventral pair of filaments medium-long to long.....	<i>S. siamense</i>
- Stalk of ventral pair of filaments very short.....	<i>S. bhutanense</i>
26 Gill with 10 filaments.....	<i>S. bagmaticum</i>
- Gill with 12 filaments or more.....	27
27 Gill with 12 filaments.....	<i>S. nemorivagum</i>
- Gill with 14 filaments or more.....	28
28 Gill with 14 filaments.....	<i>S. dattai</i>
- Gill with 28 filaments.....	<i>S. suchitrae</i> <b>sp. nov.</b>

\*\*\* *Simulium nepalense* is not included because its pupa remains unknown.

#### Mature larvae\*\*\*\*

1 Ventral papillae present.....	2
- Ventral papillae absent.....	13



2	Postgenal cleft nearly as long as or shorter than postgenal bridge .....	3
-	Postgenal cleft much longer than postgenal bridge .....	10
3	Abdomen with reddish-brown markings dorsally .....	<i>S. praelargum</i>
-	Abdomen without colored markings dorsally .....	4
4	Mandible with supernumerary serration .....	5
-	Mandible without supernumerary serration .....	8
5	Common basal stalk of gill blackish .....	<i>S. letense</i> <b>sp. nov.</b>
-	Common basal stalk of gill not blackish .....	6
6	Postgenal cleft nearly as long as postgenal bridge .....	<i>S. lekhaniense</i> <b>sp. nov.</b>
-	Postgenal cleft shorter than postgenal bridge .....	7
7	Common basal stalk of pharate pupal gill medium-long .....	<i>S. purii</i>
-	Common basal stalk of pharate pupal gill very short .....	<i>S. gracile</i>
8	Postgenal cleft slightly longer than postgenal bridge; mandibular serration composed of 2 large teeth .....	<i>S. aureohirtum</i>
-	Postgenal cleft very small; mandibular serration composed of 1 large and 1 small tooth .....	9
9	Histoblast of pharate pupal gill with 12 filaments .....	<i>S. nemorivagum</i>
-	Histoblast of pharate pupal gill with 14 filaments .....	<i>S. dattai</i>
10	Postgenal cleft long, narrow, reaching posterior margin of hypostoma .....	<i>S. butwalense</i> <b>sp. nov.</b>
-	Postgenal cleft long but not reaching posterior margin of hypostoma .....	11
11	Histoblast of pharate pupal gill composed of inflated structure with 6 thumb-like short filaments and 8 slender filaments .....	<i>S. sachini</i>
-	Histoblast of pharate pupal gill composed of 8 slender filaments .....	12
12	Ventral pair of filaments of pharate pupal gill different in thickness from each other .....	<i>S. darjeelingense</i>
-	Ventral paired filaments of pharate pupal gill subequal in thickness to each other .....	<i>S. bucolicum</i> and <i>S. siamense</i>
13	Accessory sclerite present .....	<i>S. indicum</i>
-	Accessory sclerite absent .....	14
14	Postgenal cleft long, narrow, reaching posterior margin of hypostoma .....	<i>S. suchitrae</i> <b>sp. nov.</b>
-	Postgenal cleft medium-long to long but not reaching posterior margin of hypostoma .....	15
15	Rectal organ simple, without secondary lobules; histoblast of pharate pupal gill with 6 inflated filaments .....	<i>S. tulshii</i> <b>sp. nov.</b>
-	Rectal organ compound, with secondary lobules; histoblast of pharate pupal gill with 6, 8 or 10 slender filaments .....	16
16	Postgenal cleft narrow, triangular .....	<i>S. ramosum</i> and <i>S. rufibasis</i>
-	Postgenal cleft wide, rounded or pointed .....	17
17	Histoblast of pharate pupal gill with 6 filaments .....	<i>S. himalayense</i> , <i>S. oitanum</i> , <i>S. singtamense</i> and <i>S. vega</i>
-	Histoblast of pharate pupal gill with 8 or 10 filaments .....	18
18	Histoblast of pharate pupal gill with 10 filaments .....	<i>S. bagmaticum</i>
-	Histoblast of pharate pupal gill with 8 filaments .....	19
19	Abdomen with paired protuberances dorsally .....	<i>S. tamoreense</i> <b>sp. nov.</b>
-	Abdomen without any protuberances dorsally .....	<i>S. hillycum</i>

\*\*\*\* *Simulium baglungense*, *S. bhutanense*, *S. nepalense*, *S. nuwakotense* **sp. nov.**, *S. pradyai*, *S. titareense* **sp. nov.** and *S. varicorne* are not included because their larvae remain unknown.

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## Appendix. List of species of black flies recorded from Nepal

### Genus *Simulium* Latreille s. l.

#### Subgenus *Asiosimulium* Takaoka & Choochote

1. *Simulium* (*Asiosimulium*) *suchitrae* Takaoka **sp. nov.**

#### Subgenus *Eusimulium* Roubaud

2. *Simulium* (*Eusimulium*) *jomsomense* Takaoka & Shrestha **sp. nov.**

#### Subgenus *Gomphostilbia* Enderlein

##### *Batoense* species-group

3. *Simulium* (*Gomphostilbia*) *baglungense* Takaoka & Shrestha **sp. nov.**
4. *Simulium* (*Gomphostilbia*) *bhutanense* Takaoka & Somboon, 2008
5. *Simulium* (*Gomphostilbia*) *bucolicum* Datta, 1975
6. *Simulium* (*Gomphostilbia*) *butwalense* Takaoka & Shrestha **sp. nov.**
7. *Simulium* (*Gomphostilbia*) *nuwakotense* Takaoka & Shrestha **sp. nov.**
8. *Simulium* (*Gomphostilbia*) *sachini* Takaoka & Henry, 2010
9. *Simulium* (*Gomphostilbia*) *siamense* Takaoka & Suzuki, 1984

##### *Ceylonicum* species-group

10. *Simulium* (*Gomphostilbia*) *darjeelingense* Datta, 1973
11. *Simulium* (*Gomphostilbia*) *nepalense* Lewis, 1964

##### *Varicorne* species-group

12. *Simulium* (*Gomphostilbia*) *varicorne* Edwards, 1929

#### Subgenus *Montisimulium* Rubtsov

13. *Simulium* (*Montisimulium*) *dattai* Takaoka & Somboon, 2008
14. *Simulium* (*Montisimulium*) *nemorivagum* Datta, 1973

#### Subgenus *Nevermannia* Enderlein

##### *Feuerborni* species-group

15. *Simulium* (*Nevermannia*) *praelargum* Datta, 1973

##### *Ruficorne* species-group

16. *Simulium* (*Nevermannia*) *aureohirtum* Brunetti, 1911

##### *Vernum* species-group

17. *Simulium* (*Nevermannia*) *gracile* Datta, 1973
18. *Simulium* (*Nevermannia*) *lekhaniense* Takaoka & Shrestha **sp. nov.**
19. *Simulium* (*Nevermannia*) *letense* Takaoka & Shrestha **sp. nov.**
20. *Simulium* (*Nevermannia*) *purii* Datta, 1973

#### Subgenus *Simulium* Latreille s. str.

##### *Griseifrons* species-group

21. *Simulium* (*Simulium*) *indicum* Becher, 1885
22. *Simulium* (*Simulium*) *titarensis* Takaoka & Shrestha **sp. nov.**

##### *Multistriatum* species-group

23. *Simulium* (*Simulium*) *hillycum* Maskey, 1989
24. *Simulium* (*Simulium*) *tamorensis* Takaoka & Shrestha **sp. nov.**

##### *Striatum* species-group

25. *Simulium* (*Simulium*) *bagmaticum* Maskey, 1987

##### *Tuberosum* species-group

26. *Simulium* (*Simulium*) *pradyai* Takaoka, 2008
27. *Simulium* (*Simulium*) *ramosum* Puri, 1932
28. *Simulium* (*Simulium*) *rufibasis* Brunetti, 1911

##### *Variegatum* species-group

29. *Simulium* (*Simulium*) *himalayense* Puri, 1932
30. *Simulium* (*Simulium*) *oitatum* (Shiraki), 1935
31. *Simulium* (*Simulium*) *tulshii* Takaoka & Shrestha **sp. nov.**
32. *Simulium* (*Simulium*) *vega* Maskey, 1998